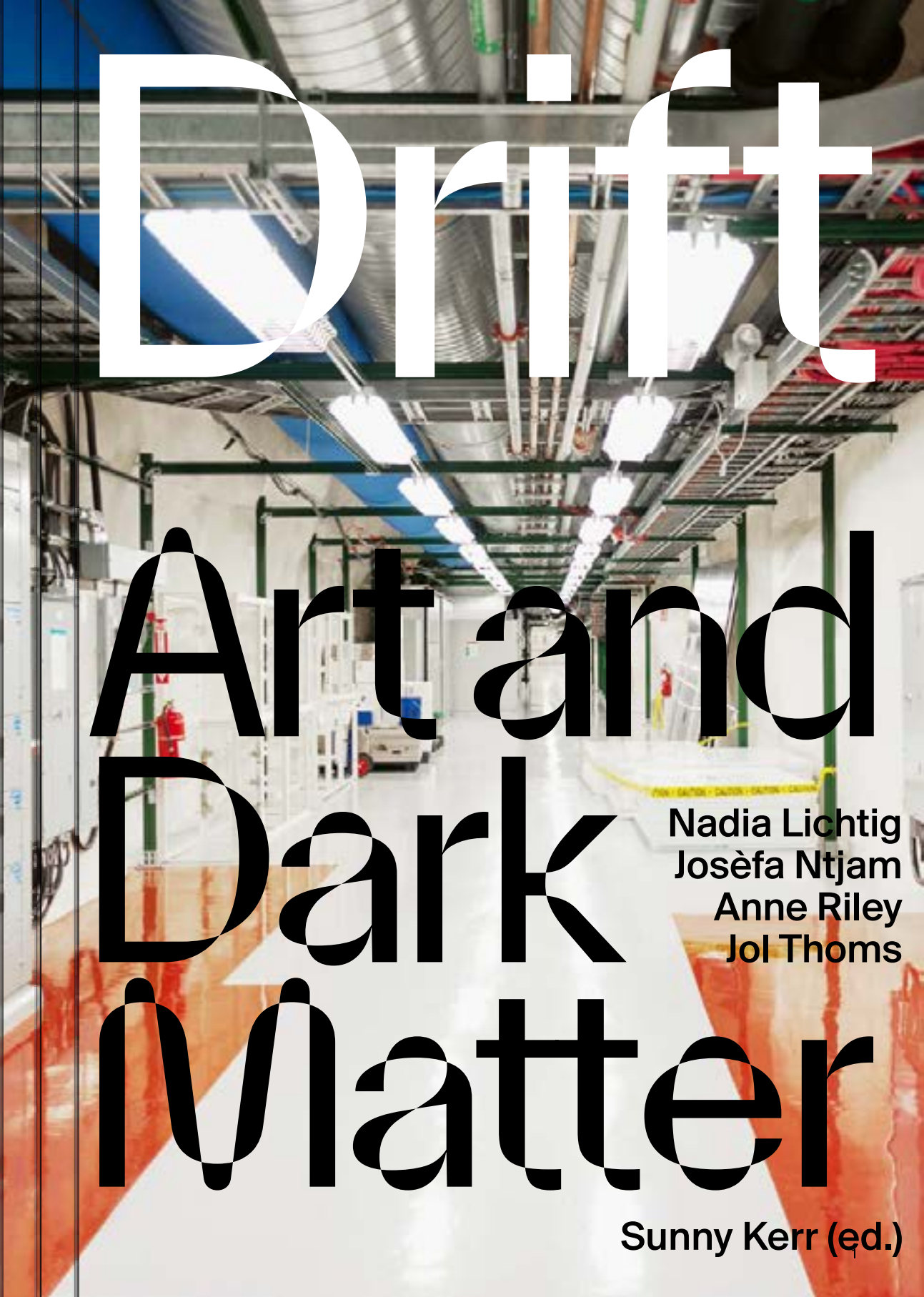
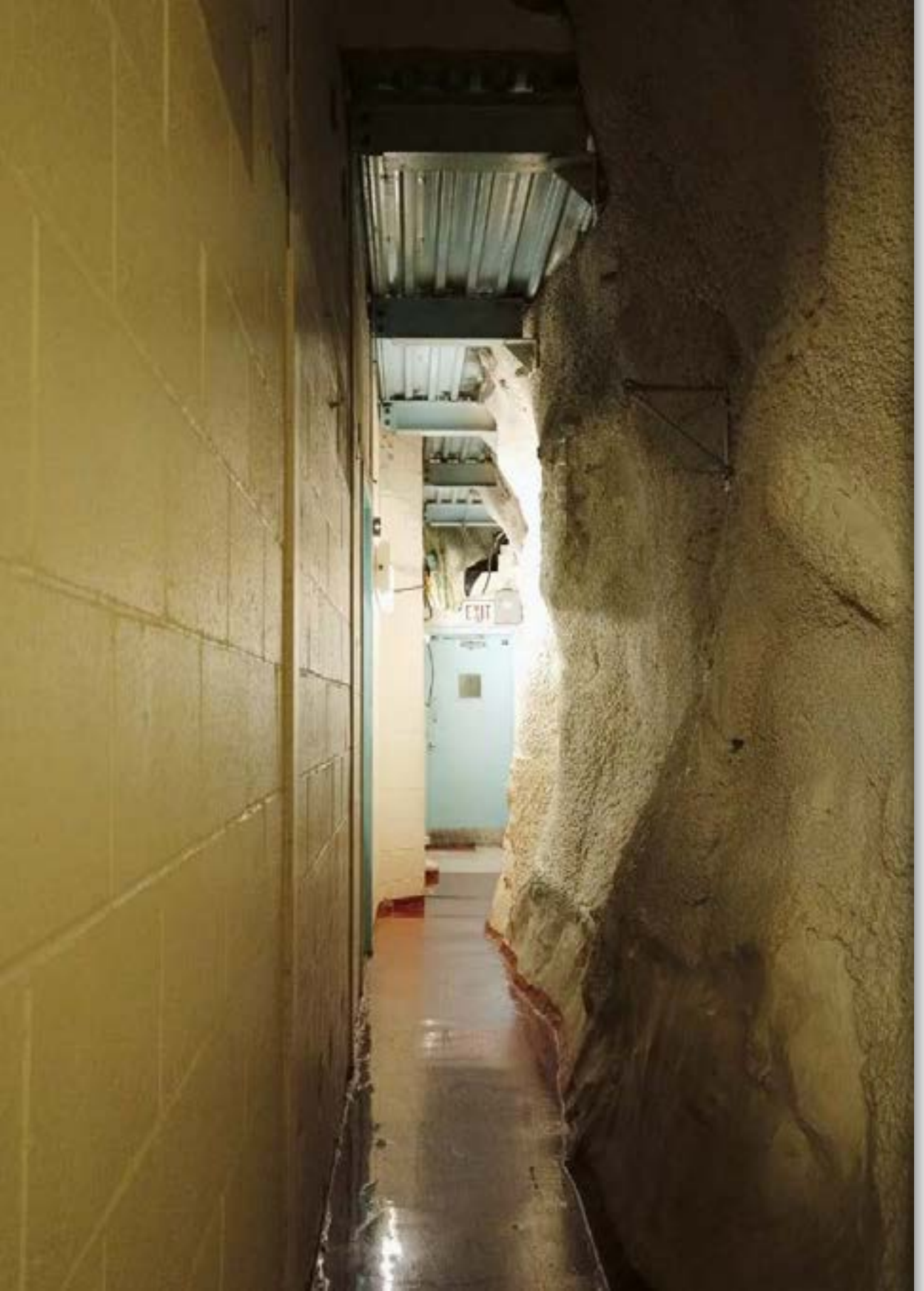


Drift

Art and Dark Matter

Nadia Lichtig
Josèfa Ntjam
Anne Riley
Jol Thoms

Sunny Kerr (ed.)



Drift

Art and Dark Matter

K. Verlag & Agnes Etherington Art Centre
Arthur B. McDonald Canadian Astroparticle Physics Research Institute
Art Museum at the University of Toronto
Carleton University Art Gallery
Morris and Helen Belkin Art Gallery
SNOLAB

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Forays in the Underburden

SUNNY KERR

In 2018, Agnes Etherington Art Centre was invited to think with dark matter by the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute) and SNOLAB. In group forays—which included the participating artists Nadia Lichtig, Josèfa Ntjam, Anne Riley, and Jol Thoms—we journeyed deep under the surface of the Earth on the traditional territory of the Atikameksheng Anishnawbek First Nation, Robinson-Huron Treaty territory, now Sudbury, Canada. After plunging two kilometres into Creighton Mine #9 in an industrial elevator, we parted ways with the groups of miners who were heading to work and walked laterally into the ground through a hot dark mining drift, a horizontal passageway that follows the vein of a mineral deposit. To reach SNOLAB, scientists walk together in their boots, orange coveralls, and headlamps through a drift in the active Vale copper and nickel mine to antechambers, where they shower and change their clothing before entering the brightly lit, ultra-clean physics laboratory. When the lab's astroparticle detectors are switched on, the mass of underground rock located above them is effectively converted into an essential component of various particle sensing technologies. While we were only down in the lab for day trips during two week-long visits that were part of the residency, the subterranean visit provided an exceptional point of departure for the exhibition (and eponymous publication) *Drift: Art and Dark Matter*. As the curator of the exhibition, in what follows, I trace the polyvocal potentials of the artistic works and approach them as sensory agents that have emerged alongside the search for undetectable dark matter in the incomprehensibly vast Universe that it improbably holds together.

Mattering Out of Sight

Unseeable matter exists, slipping past flows of light, unaffected by forces binding together more familiar material realities. Making up most of the matter in the Universe, its gravitational energy seems to hold galaxies together. Not only does this so-called "dark" matter contribute to the cosmos being held together, but scientists have also proposed that many galaxies would never have been born without its constituent mass.[1] While it imperceptibly and indifferently passes through us, dark matter scaffolds the conditions of our own origins and becoming-life on planet Earth.

With the aid of the norite rock's density, more common particles are slowed and filtered out, allowing SNOLAB experiments to search for both rare and speculative particles. The affordances of deceleration are well known to artists; indeed, artworks can preserve fluxes of sensation that otherwise pass too quickly to be noticed.[2] Artists and curators slow down

1 NASA, "Galaxies Over Time," James Webb Space Telescope (website), jwst.nasa.gov/content/science/galaxies.html.

2 In Gilles Deleuze and Félix Guattari's model of aesthetic experience, intensities mark the limits of perception and much of reality is virtual (real but not actual). An artwork is a "bloc of sensations, that is to say, a compound of percepts and affects." In art's encounter with visitors, universes of reference set off new refrains. See Gilles Deleuze and Félix Guattari, *What is Philosophy?*, trans. Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1994), 164. Notably, in another work, Guattari quotes Marcel Duchamp proclaiming, "Art is a road which leads towards regions which are not governed by time and space." See Félix Guattari, "The new aesthetic paradigm," *Chaosmosis: An Ethico-Aesthetic Paradigm*, trans. Paul Bains and Julian Pefanis (Bloomington: Indiana University Press, 1995), 101.

and organize chaos. As an analogy, slowing helps me to think about art as a grounded beginning for *Drift: Art and Dark Matter*, a project adrift within a multiplicity of ungrounded zones, as well as various traversals, anticipations, and disjunctions.

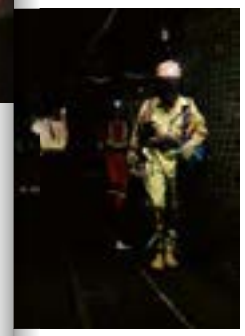
Like particles decelerated by the cold terrestrial mass of the Sudbury Basin, overzealous questions can also be slowed, as well as given shape in and through the materials of art and written speculation, and thereby fully encountered. Questions about the Earth, the body, language, mattering, and agency emerge along with the work of the *Drift* residency artists. What drives the desire to isolate and detect dark matter? Through what pragmatics and unconscious transferences is it established as a scientific problem? What worlds make its stories? Could we already have a non-sensory affinity or non-rational kinship with dark matter?[3] Does dark matter already contribute to the sensible, even if its role is beyond our contemporary comprehension? What power and freedom, multiplicity, or wild agency are indefinite and alive within the Earth and within bodies? What worlds can dark matter's stories engender? What might it help reveal of a people yet to come?

Given dark matter's strict incompatibility with the human senses, artists in the *Drift* residency looked right through it, or past it, and instead found other connections to both the laboratory and the Earth. They began by addressing the material and conceptual supports and speculative repercussions of dark matter's "known unknown" condition rather than contriving to represent the non-visual.

Anne Riley's key work, *dark matter garden* (2021–ongoing), for example, steps past experimental detection and begins instead with the land and deep time. It takes the form of a gift of commitment to, and care for, a piece of the planet and all life that might pass through it over eons, both past and future. This work is carefully attuned to healing the land and deepening a multitude of relations with and through it; in our present context, the work meets contemporary oppressive systems, conflicting ways of occupying the land, and differing accounts of invisible forces that surround us. Significantly, Riley meets them outside the gallery and outside the exhibition timeline to reach for a spacetime of renewed freedom.

To discuss her intentions for this expanded garden form, in 2019, Riley began reaching out to Elders within Anishinaabe and Haudenosaunee communities in now-Kingston, Canada. In August 2021, she heaped soil and rich mushroom compost into an oval shape about nine metres in length on the lawn of Agnes Etherington Art Centre. Nourishing the life that is already there, she also communicated an open invitation for Elders to plant in the zone. Agnes Etherington Art Centre has committed to stewarding relationships around the piece and attending to the work's ongoing teachings; among these, practising complicity with the occluded land and excluded peoples. The local university staff will continue to manicure the lawns and plant annual flowers

Anne Riley installs *dark matter garden* in front of Agnes Etherington Art Centre, 2021. Photo: Tim Forbes



Zac Kenny from the McDonald Institute walks through the drift. Photo: Gerry Kingsley

around it but will leave the oval region to recover as a space of small but tangible Indigenous freedom or to simply regain a circumscribed but genuine wildness in peace.

Artistic participation in these contexts requires a magnitude of labour that is largely invisible to settler-colonial partners.[4] Extraction and denial prevail in institutions and coalesce into a continued ignorance of the hidden workings of power within modes enacted with even the best of intentions.[5] For this project, thinking with extra-colonial time and the darkness and softness of soil, Riley instead seems to figure her own emotional labours toward social healing as engendering a form of kinship with dark matter. *dark matter garden* is suffused with care and respect for life, and this may buoy her labouring-in-solidarity to allow it to reach beyond bitterness, to intra-act with a small patch of land. Evading oppressive mass, bending spacetime, the work may move joyfully, as if alongside dark matter's indifferent velocity.

In a 2019 performance called *I am nameless*, Josèfa Ntjam looped and manipulated poetic chants until, in the final moments, her repeating voice was pushed lower, granulated, and abstracted.[6] This granulation suggests permeable molecular states of organization that allow difference to operate in stable conceptions of the self, collectivity, or the Earth, recalling the exchange and resistance of particles between matter.

Ntjam's installation for *Drift* includes *Luciferin Drop* (2020), a large blown-glass beaker-like vessel containing glowing green liquid and resting on a stand fashioned from four replicas of human feet. The sculptural bare feet evoke a sensitivity to touching the ground while simultaneously striking a transient and fugitive stance signalled by speed-blur lines. Meanwhile, Ntjam assembles layers of mimicry and associations with extraordinary deep places and times: among them, Western science's hidden histories in Africa, galaxy rotation, the enzyme that causes bioluminescence, and glowing flashes prepared in underground particle detectors at SNOLAB. The sculpture seems to take direct inspiration from the use of scintillating fluid to reveal particle interactions in the liquid argon-based DEAP-3600 dark matter detector or the SNO+ neutrino detector.[7] At such remote thresholds, the deep seems to urge transformation: like deep-sea creatures, SNOLAB's deep-Earth prosthetics bring inventive modes of sensation ever closer to what has never yet been perceived.

3 Physicists suspect that even if it is a particle, dark matter will remain opaque to unassisted direct perception. And yet, wouldn't dark matter contribute directly (or indirectly) to the gravity we experience as weight on Earth?

4 For Anne Riley, engaging with modern, white-coded art or Western science systems as a Dene artist presents the risk of increasing the burden of trauma, the result of the wrongs still inflicted on Indigenous peoples. Indigenous artists might experience Western science and art systems complexly as symptoms of a centuries-long state of emergency, as suspicious mechanisms of an intruding force, or sometimes begrudge them as presently unavoidable pathways. Conversation with the artist. See also Anne Riley, "Įladzeeé: Pulse in the Wrist," *MICE Magazine* (Spring 2016), micemagazine.ca/issue-one/%C4%AFladzeee%CC%81-pulse-wrist.

5 Whether land is the explicit object of one's focus or not, one's artistic practice is forced to be associated with the expropriation of land and dislocation that is a legacy of colonization. Frequently, one's identity gets foregrounded by institutions in a way that allows (re-)racialization that normalizes systemic practices. In these institutions, one is occasionally included, and overtly or subtly asked to do the work to represent one's identity group, marked as rescued victim, or expect to share special cultural wisdom. And then one is even asked to labour in the effort to decolonize science and art. For these artists, institutions are fraught with dangers as systems that consciously or unconsciously threaten both extraction and normalization, all with "virtue signalling" smiles. Broken trust takes time to reconstitute. It is rare for decolonizing institutions to take the real risks required for the beauty of real change. On these and many other questions related to settler-colonial politics, see Glen Sean Coulthard, *Red Skins, White Masks: Rejecting the Colonial Politics of Recognition* (Minneapolis: University of Minnesota Press, 2014).

6 Josèfa Ntjam, *I am nameless* (2019), vimeo.com/376128569.

7 SNOLAB, "Active Experiments," snolab.ca/science/experiments.

Ntjam's video installation *Myceaqua Vitae* (2020) carries the viewer through a vast rotating starfield until a giant water droplet slips through the centre of a spinning galaxy (narrated as the birth of a luminescent mushroom), and it then plunges viewers into the planetary—through what one imagines are successively smaller particle zones of molecules, atoms, and so on. Together, Ntjam's imagery and poetic narration evoke fractal relationships of scale and hint at recursive flows of time. To create a kind of sci-fi viewscreen station, Ntjam plants a circular textile work, called *Organic Nebulae* (2019), on the ground in front of three screens. This carpet is adorned with digitally assembled images of uncategorizable mauve entities and a Benin ceremonial mask, among other things. The appearance of the West African mask evokes differing sciences, non-Euclidean geometries of past and future—like the mathematics from the plundered ancient flourishing capital of Edo.[8] Ntjam insists upon such a liberatory potentiality already at work—not in origins or destinations, but in fugitive solidarities of life across space and time.

From a human perspective, dark matter indicates a curious excess within existence, for it is extraneous to the direct particle building blocks of "regular" matter. Likewise, art exists in speculative and aesthetic excesses far beyond reason and utility, often resulting in unaccountable strangeness (from a human perspective). The art in the *Drift* exhibition can seem even more fantastical for its proximity to the rationality of science. Ntjam repurposes representational strategies from biology, chemistry, physics, and science fiction to disclose unfathomable intensifications of beauty. Physicist Dr. Tony Noble remarked that the feet in *Luciferin Drop* make it look like a wildly unwarranted crustacean body. As we will see, while it may not be arranged to affirm it, science, too, reaches such strangeness beyond reason and utility.

The sound of inhalation in a darkened room. Light falls on regions of marked cloth and then jumps across the ground, glowing briefly and fading in new spots, fluctuating in synch with sounds of breathing and vocalizing. In Nadia Lichtig's *Blank Spots (Reichstagbunker)* (2017–22), breath and intoning voice sounds are linked to a theatre lighting sequence that frames and reframes sectors of unstretched canvas frottage on the floor; their sonic and visual shifts are near-simultaneous. The aggregation of breath, sound, light, and earthly canvas forms an indefinite being, a space for considering life as a cosmic phenomenon and consciousness as entangled with the Universe. This near simultaneity recalls the theory of non-locality, whereby particles at a distance may be linked as if they are a single entity.[9] Bodies are re-linked, adjusted as singularities formed with the air we breathe and waves of sound, only tenuously distinct from the ground we walk on.

Each canvas has been hand-coloured with careful site-specific rubbing and drawing processes that sometimes result in traced patterns evoking flooring or sometimes recall

Jol Thoms, *n-Land* (still), 2021, video, 5.1 sound, 17 mins. Collection of the artist

Jol Thoms, *n-Land* (still), 2021, video, 5.1 sound, 17 mins. Collection of the artist

SNOLAB staff provide the *Drift: Art and Dark Matter* team with an explanation of CUTE (a Cryogenic Underground Test Facility). Photo: Gerry Kingsley

8 See Mawuna Koutonin, "Story of cities #5: Benin City, the mighty medieval capital now lost without trace," *The Guardian* (18 March 2016), theguardian.com/cities/2016/mar/18/story-of-cities-5-benin-city-edo-nigeria-mighty-medieval-capital-lost-without-trace; Paulus Gerdes, "On Mathematics in the History of Sub-Saharan Africa," *Historia Mathematica* 21 (1994): 345–76.

9 George Musser, "How Einstein Revealed the Universe's Strange 'Nonlocality,'" *Scientific American* (1 November 2015), scientificamerican.com/article/how-einstein-revealed-the-universe-s-strange-nonlocality.

stains created from scouring blemishes or spills. In both cases, the frottages convey a searching intimacy with the ground and a sense of exhaustive repetition. Lichtig's *Blank Spots* ritually draws household or familiar dust from the ground and puts it into analogous relation with the cosmic dust that is purportedly the foundational stuff of all earthly matter, the vestiges from exploded stars that are "regular matter." Playful translations in Lichtig's work include associating stardust with what she calls "unglamorous" dust. Her series of five photograms, *Dust (Reinigungsarbeiten)* (2020), takes visual traces of cleaning work through transmutations wrought by scalar ambiguity to express reveries of the cosmic.

It is key to remember that although we don't seem to need dark matter, we're indebted to it in ways we haven't yet learned to appreciate. While making up most of the matter of the Universe, dark matter is thought to be decaying matter leftover from the Big Bang.[10] Lichtig's provocations cover more ground if dark matter may be compared to lingering wreckage, like the material traces of history that are around us every day yet dismissed as waste. We forget, deny, or take for granted dark matter's role in creating us and our conditions. What if dark matter could be theorized through the materiality of such oblivion, in and through those things that don't appear as useful, but which are, in reality, essential. Walter Benjamin articulates the estranged traces of non-linear time carried by the debris of history in his final essay, "On the Concept of History."[11] One could say, taking up Benjamin's thread, that what we tend to think of as debris is actually a multiplicity of connectors among apparently disparate spacetime continua. Similarly, overlooked dust drawn from the oppressed past enables new senses of becoming in Lichtig's work, where thought may drift with dark matter past the certainties of progress and earthliness.

The Earth is brought into focus again through Jol Thoms's installation *n-Land: the holographic (principle)* (2021), especially by way of a large relief map of the impact crater made by the comet that created the Sudbury Basin 1.85 billion years ago. The hum of industrial ventilation and the wisps of a wind tunnel—sounds that Thoms recorded in the underground drift—saturate the room. Thoms delicately fastened shatter cones and norite rocks that he acquired from museum giftshops into brass sculptural armatures. He diagrams the land in every layer of his speculative assemblage of images, apparatuses, and stories. The central video, *n-Land*, draws us from pre-ancestral comet impact, down through underground mining and laboratory spaces, where we encounter some of the measureless implications of the many-worlds interpretation (MWI) of quantum mechanics as relayed by the altered voice of Dr. Miriam Diamond. The video then re-surfaces to dwell on the autumn landscape above ground as intertitles acknowledge the local First Nations. Incorporating scans of archival records of the 1850 Robinson-Huron Treaty into the video (as well as the prints and photocopies of recent legal documents in the

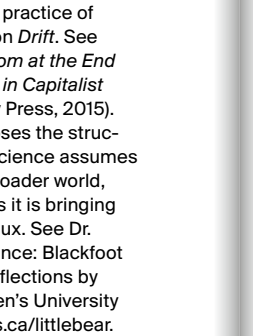
10 Chanda Prescod-Weinstein, *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred* (New York: Bold Type Books, 2021), 20.

11 Walter Benjamin, "On the Concept of History," in *Walter Benjamin: Selected Writings, Volume 4, 1938–1940*, eds. Howard Eiland and Michael W. Jennings, trans. Edmund Jephcott et al. (Cambridge: The Belknap Press of Harvard University Press, 2006), 389–400.

installation), Thoms refers to the current annuities case through which the local Anishinabek First Nations are challenging the Canadian government's failure to honour the Robinson-Huron Treaty. How would the story of progress change if the obscured matter of its victims and protagonists were seen to be lending agency to each other?

Thoms's conception of landscape-laboratories as deterritorialized scientific assemblies (or new modes of Earth-ing) informs his artistic construction of associative layers; these layers might collectively enunciate unexplored disclosures of potential new adjacencies. He expands the repertoire for thinking landscape-laboratories in this work with the holographic model borrowed from theoretical physics, along with diffractive methods developed by Karen Barad; with these conceptual allies, *n-Land: the holographic (principle)* traces the interference of earthly and cosmic layers across dimensional projections. For Thoms, such a method might open human thought to realizing its intra-active diffractive relationship.[12] From such de-centred coordinates, dark matter's opaque-yet-gravitational assembly might suggest that Western culture's inheritance of subject-object separability is inadequate to the task of knowledge. How does the acquisition of artistic and scientific knowledge participate in the project of colonialism by insisting on logics of separability? Can we learn from dark matter how to evolve beyond cultural and environmental extraction and its engine of rapacious capitalism and instead strive for relations beyond taking (and knowing)?

Often, astroparticle physics asks us to look far afield: out into distant space, to the origins of the Universe, to weird quantum states, or to a future time. While the artworks in *Drift* often retain certain attachments to Western scientific concepts, they also try to incorporate bigger questions profanely and approach them as things we share in. It is commonplace that science and art function through looking with "new eyes." Art often begins by "looking again" and "looking around" at the strange within the earthly familiar.[13] The experience of travelling underground together to SNOLAB may have helped to expose the enigmatic within the terrestrial. Drawing from the limitations indicated by the singularity of dark matter itself, each of the artists brings the Earth into contact with a variety of speculatively decentred perceptions. How do we make a hospitable home (*oikos*, eco-) in a largely imperceptible universe of chaos and change?[14] Such an ungrounded grounding allows the artists to reorder elements into art. As their earthly imaginings reach beyond individuated human consciousness and its practices of life, time, or space, they enable artistic speculations about the body in a more concerted assembly.



Bubble chamber detector PICO. Photo: Jol Thoms

12 Thoms is probing the ethics of Karen Barad's diffraction methodologies and onto-epistemology. Intra-action "describes the mutual constitution of entangled agency, that is the mutual constitution of our ability to act." See "intra-action," makecommoningwork.fed.wiki/view/intra-action; and Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).

13 Anna Lowenhaupt Tsing's take on the practice of "looking around" is a clear influence on *Drift*. See Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015).

14 An insight from Leroy Little Bear exposes the structures of differing sciences: Western science assumes it discovers the hidden order of the broader world, whereas Indigenous science assumes it is bringing local order to a universe of constant flux. See Dr. Leroy Little Bear, "Rethinking our Science: Blackfoot Metaphysics Waiting in the Wings. Reflections by a Blackfoot," a public webinar at Queen's University Biological Station (12 April 2021), qubs.ca/littlebear.

Anne Riley gives an artist talk at SNOLAB. Photo: Zac Kenny

Matters That Em-body

Bodies are both aesthetic and anaesthetic, sensitive and self-shielding. Like a giant kidney, the two kilometres of rock between SNOLAB and the surface of the Earth filters out particles and radiation that researchers are not searching for, thereby suppressing the cosmic background. Both art and science often require types of isolation through techniques of filtering and shielding to obtain their desired results. In the case of art, infrastructural filters often perpetuate forms of concealed authority hiding within an apparently critical platform. For example, the art gallery's "white cube" space claims a Euclidean universalism and neutrality maintained by eliminating or absorbing so-called "minor" cultural ways, associative behaviours, or adjacent sensations. Science largely filters out and dislocates sociopolitical and ethical questions; art permits, celebrates, and recognizes them—only to the point of simulating temporary freedom, releasing the pressures of general antagonism.[15]

Space often appears in science and art as an abstraction or metaphor de-linked from bodies. Reversing this tendency, Josèfa Ntjam welcomes the visitor's body into the spacecraft form of her installation and its circular sense of scale wherein the tiny and the vast are visited at once.[16] Its curvilinear spacecraft console visualizes "alien" signals. She uses the familiar motif from science fiction to construct a prophetic image of science as seen from embodied perspectives unthinkable in our present.

Anne Riley's insistence on cultural healing begins from an acknowledgement of the violence enacted through and on bodies by the logistics of ruling social relations. Her video document, *the heart of the matter*, features a recording of a video call in which she speaks directly to visitors about the possibility of saying "I love you" to herself in Dene and what this might do. Her question develops in relation to specific forms of change to her body that could help recover such an ancestral belongingness for the future—a hidden love. In a parallel to the scientific search for dark matter whereby SNOLAB's experiments "feel for" signals of rare particles (beyond touch as we perceive it), Riley's focus on the sensory being and possibilities of the body initiates a different kind of search.

Riley's attention to emotional labour also underscores how frequently settlers demand Indigenous artists address the appearance or disappearance of Indigeneity through an insistence that compounds colonial oppression of racialized and Indigenous peoples. In the context of *Drift*, a demand converges on Riley to reveal and articulate Indigenous cosmology, or, in some way to react to Western science explicitly on behalf of her culture. The *Drift* project presumes, perhaps, to share Riley's identity. Instead, she studies invisible-ized relations and curiosities carried by the body.[17] She points to the ways in which queer and

15 Stefano Harney and Fred Moten, *All Incomplete* (Colchester: Minor Compositions, 2021), 124.

16 Neil Smith and Cindi Katz, "Grounding Metaphor: Towards a spatialized politics," *Place and the Politics of Identity*, eds. Michael Keith and Steve Pile (New York: Routledge, 1993), 67–83.

17 A previous work by Anne Riley and T'uy't'tanat-Cease Wyss, *Soundtrack for the Radical Love of Butterflies* (2018), is an audio cassette that draws attention to the shrouded transformation of the butterfly (in the context of Mike MacDonald's work). A total change (holometabolism, as scientists name it) occurs in the dark of the cocoon.

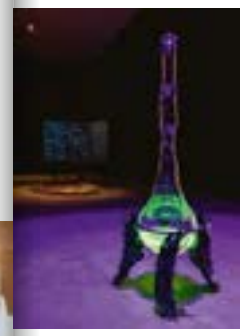
Indigenous bodies and desires have been imperceptible to institutions, always empowered in solidarity, yet disregarded in the genuine formation of institutional visions.[18] She evokes an excluded "body" analogous to an "undercommons" or "the surround" in Stefano Harney and Fred Moten's terms, as well as the multitudes of support workers and unseen artists in Gregory Sholette's metaphorical dark matter.[19]

Emotional labour is, at first glance, akin to direct particle detection—as if it were the registration in the body of unseen mass. With *the heart of the matter* and *dark matter garden* Riley seems to organize her own variety of filtering, rather, to supress the "background" of colonial "noise" in science and in art to create a quiet, energetic space amenable for healing with human and non-human relations. Rather than knowing, the body is involved in joining. Riley makes the body visible in her video while entailing a hidden matter, a longed-for presence.

Nadia Lichtig's *Blank Spots* conjures the absent body that exhales and sings, the human who rubs canvas against the ground to create frottage. The visitor's body is redoubled in intensity. The work entails an artistic subjectivity that is tracking a cartography, and, we discover, constellating crime scenes. Lichtig figures her own search for the missing within her personal story, one "smuggled in" and not directly available in the work.[20] She has created frottage work from various locations—Vancouver, Bremen, Aix-en-Provence, Montpellier, Zamość, and Poznań. Ongoing, Lichtig makes each on grounds where a traumatic event took place (such as in the Reichsbahnbunker in Berlin). What traces of the Holocaust are perceptible in the dust drawn into these blotches and rubbings? Not an end, however, Lichtig's indexing of each frottage to a specific place is a first step in a complex aesthetic encounter; an impasse appears where the sublime might enter. Through the absurd image of scrubbing or tracing wrongs of such magnitude, Lichtig discloses a destitute irrationality whereby the body cannot know, the intellect might collapse, hand rebuffs representational gesture, and voice reaches a kind of nothing-space that sings beyond language.

Experiments built in SNOLAB are sensing apparatuses that extend far beyond human bodily capacities as they look for signals through great silent tanks waiting deep underground. Jol Thoms observed that artists are also sensitive; they're stereotyped, of course, as having receptive temperaments, but they have developed their perceptual capacities by training their attentions upon affects arising from the tiniest material decisions.[21] Deep in the mine, Thoms turned the detector into a camera and focused it on the artists' bodies. Thoms's group portrait, *Drift Decay Portrait (SNO+)* (2020), deploys the SNO+ neutrino detector and its data visualization, which he video-captured as a computer indexed and translated the radiation detected on our own bodies when we visited the lab. The detector shows these bodies as effecting an interference of singularities, and it also marks bodies as out-of-place, unclean, and threatening, carrying extraneous matter that has slipped past the filters. With *Drift Decay Portrait (SNO+)* Thoms turns the detector's readings into an affective readymade.[22]

During the residency, the artists Nadia Lichtig, Josèfa Ntjam, Anne Riley, and Jol Thoms visited a variety of locations in both Sudbury and Kingston. Pictured here is Josèfa Ntjam in Peng Wang's chemistry lab at Queen's. Video: Zac Kenny



Josèfa Ntjam, installation view of *Myceaqua Vitae*, 2020, video with sound, 7 mins. and *Luciferin Drop*, 2020, glass, metal, ABS filament and luminescent liquid. Photo: Tim Forbes

Especially when considered from a higher spatial point of view in the exhibition, Lichtig's *Blank Spots* shares some visual motifs with the detector data visualization screens recorded in *Drift Decay Portrait (SNO+)*: signals coming in as irregular translations populating and depopulating chart-like areas. Lichtig, like Riley, could be said to be looking into the body for dark matter. Might artistic senses become so sensitive? Could artists, with time and practise, become dark matter detectors? According to scientists, no. Even if a human being trained and evolved over millennia to become ever more sensitive, they could never achieve unassisted perception of dark matter. Yet, it is in us and around us in a way that is *differently physical*. If we consider dark matter as a thing that is here with us, as it is with all parts of space, it may provide a useful conceptual framework: an invitation to entertain and accommodate what is not sensible but potential.[23]

The darkness, voice, and flickering lights of *Blank Spots* invite a hypnotic transport and loss of boundary. Marion Dufour suggests Lichtig's work can be understood as inviting a getting-in-sync with the artist.[24] This begins with being present with one's own bodily thresholds and letting go of one's "program." Lichtig's *Headless (Dark Matter)* (2018–19) series of paintings combines digital prints on canvas with charcoal mark-making. The charcoal plays the roughly analogous part of dark matter, loose on their surfaces and spreading onto gloves, hands, or doorknobs. The series title suggests Lichtig's privileging of process over ends, a "beheading" of the superego narratives of the self in favour of being-with material differently.

Another Framework Is Possible

I found myself trying to articulate to physicists and science communication specialists focused on the Standard Model or on symmetry, that artists are often interested in revealing, escaping, or reshaping frames. For example, some of the first works Nadia Lichtig showed me after visiting SNOLAB were like un-framings: drawings, found materials, and wooden frames arranged like diagrammed frozen disintegrations of artworks.[25] "What you think isn't all," claims Sam Gilliam regarding the power of abstract painting.[26] Doesn't science also thrive on frame-breaking? I was told thatscience's frame-breaking is always course correction in aid of the tweaking of functional certainties.

18 Conversation with the artist.

19 See especially "Politics Surrounded," in Stefano Harney and Fred Moten, *The Undercommons: Fugitive Planning & Black Study* (Wivenhoe: Minor Compositions, 2013), 15–20; and Gregory Sholette, *Dark Matter: Art and Politics in the Age of Enterprise Culture* (London: Pluto Press, 2011).

20 Conversation with the artist. See also Marion Dufour et al., *Nadia Lichtig: Pictures of Nothing* (Berlin: Kerber, 2014), 64.

21 Conversation with the artist.

22 I prefer Stephen Zepke's geneology of the ready-made wherein art is recognized within life rather as conceptual nomination of fragments of life as art and appearing in the disciplinary apparatus of art. See Stephen Zepke, "The Readymade: Art as the Refrain of Life," in *Deleuze, Guattari and the Production of the New*, eds. Simon O'Sullivan and Stephen Zepke (London: Continuum, 2008), 33–44.

23 Denise Ferreira da Silva's text in this volume advances this position; such a conceptual framework holds promise for differing valuations of collectivity not dependent on naturalistic individual bodies, allowing for prosthetic assemblages that are nonetheless intimate and connective. The authorial gesture itself could thereby be understood to come from "social individuals" or clusters.

24 Marion Dufour, "Echoes of Language," in *Nadia Lichtig: Pictures of Nothing,* 82.

25 These could be read as extensions of Lichtig's series, titled *(Un)unframed* (2012–ongoing), in which drawings/event scores appear in hinged frames like opened windows. See the artist's website, "un-unframed," nadialichtig.com/un-unframed.

26 Sam Gilliam, "Abstract Art is Political," Louisiana Channel, Louisiana Museum of Modern Art (2020), youtube.com/watch?v=ciN6ZPDMJV4&ab_channel=LouisianaChannel.

For Michel Foucault, art's greatest power is active in disclosing epistemic frameworks; it is not in "showing the invisible, but rather showing the extent to which the invisibility of the visible is invisible."[27] That is, the institutional frame, which crops out and obscures the potentially visible, becomes itself an invisible frame through which science (and art) institutions structure what can be said and what can be heard as if they were giving events privileged permission to occur in value-free space. Notwithstanding art's own exclusions, Kathrin Busch engages this insight to refer to the potential in art's difference from science: art "permits, therefore, a subversion of science when it refers to the exclusions inherent in scientific knowledge production."[28] The search for dark matter is a special case of framing. Can artists address dark matter without exploring the visible and invisible frames science is instantiating? After all, physics foregrounds the known elements (calculations of galaxy rotation, gravitational lensing measurements, etc.) that form the epistemic frames determining the shape of the unknowns of dark matter.

If the content is invisible, the framework itself is ever more apparent, as we've seen with the body and the Earth. If artists are invited to represent dark matter, to bring the unseen to light and make visual the strictly non-visual, it is appropriate, rather, that dark matter's suprasensible opacity and sensory transparency reveal to their fresh eyes what is right in front of us: the invisible frames made up of prerequisite disciplinary cultural scaffolding, the frames of material infrastructures, and the machines that drive and convey unconscious motivations to detect it.[29] The invitation turns the artists toward an exploration of the methods and practices of mattering whereby we might make connections to social, material, historical, and speculative contexts; they practise interfering in active constellations of materials and ideas.[30]

Dark matter must be thought of as dependent upon a certain kind of measurement, an imperceptible matter considered missing only according to the measurement of a finite gravity "budget." Considering the singularity of the search for dark matter is a way of bundling dark matter along with its narrative frames in a way that allows one the chance to continually approach the complexity of how it is mattered.[31]

In Lichtig's *Blank Spots*, the lights installed above the canvases constantly delineate

27 I'm grateful to Elvira Hufschmid for bringing this text to the residency process. Kathrin Busch, "Artistic Research and the Poetics of Knowledge," *Art & Research: A Journal of Ideas*, *Contexts and Methods* 2, no. 2 (Spring 2009), artandresearch.org.uk/v2n2/busch.html. For his most comprehensive elaboration of this idea, see Michel Foucault, "La philosophie analytique de la politique," in *Dits et écrits, 1954–1988, vol. 3, 1976–1979*, eds. Daniel Defert and François Ewald (Paris: Gallimard, 1994), 540–41.

28 Busch, "Artistic Research and the Poetics of Knowledge."

29 This idea is relayed from a discussion with Emelie Chhangur that was essential for revealing the insight that certain opacities in the project turn artists toward methods and collectivity.

30 The manner of *mattering* becomes key. Guattari usefully addresses an influence aesthetics brings to politics: its ability to confront Being assumed as "inert facticity" and the ideal of the Universe as passive and undifferentiated. This deployment of aesthetics gels in what he calls ecosophical thinking: "The emphasis is no longer placed on Being—as general ontological equivalent, which, in the same way as other equivalents (Capital, Energy, Information, the Signifier) envelops, encloses and desingularises the process—it is placed on the manner of being, the machination producing the existent, the generative praxes of heterogeneity and complexity." See Guattari, *Chaosmosis: An Ethico-Aesthetic Paradigm*, 109. A longer study could productively compare Guattari's science-inspired non-ontology with the "generative praxes" of Karen Barad's feminist science studies and their common concern of centring ethics.

31 A singularity, according to Levi Bryant, is "that within a thing that will generate qualities and shape when a thing enters into a particular field of forces." He continues, "singularities are points of tension and potentiality within matter or a thing that are absolutely unique to that thing." Finally, "things always harbor topological singularities whose effects, when entering into this field of forces, cannot be calculated." See Levi R. Bryant, "What are Singularities?" (14 June 2012), larvalsubjects.wordpress.com/2012/06/14/what-are-singularities.

and define them, creating one instantaneous compound after another of framing, the framed, and the unframed. The traces of translation and non-translation between medium and language, observable most directly through Lichtig's related *Blank Spots (Reichstagbunker) Score* (2022), speak to aesthetic scanning practices and speculative leaps. The situatedness that is consciousness as a process is activated with all its points of porosity, leakage, opacity, and breakdown.

Anne Riley refuses to engage directly with the pre-existing frameworks drawn by mathematical calculation; her works thereby make visible the invisible quality of the expectations of presence and legitimation. Instead, she reframes what might be outside of understanding as being akin to a subjugated vital cultural heritage. In this situation, study constitutes the detection of and collusion with these past, present, and future peoples. In plotting this orientation, Riley's playful negotiation also threads the spatio-temporal frame of an exhibition. *dark matter garden* is literally and figuratively outside, composed of nutrient-rich soil that is allowed to wild-seed, a mound of compost given to whatever is there. The piece's assertion of space outside the art system's galleries and its regular schedules is a kind of lively generative practice of dark matter. By developing *dark matter garden* from a transdisciplinary residency, yet slowing and eschewing participation in prescribed framing, Riley might draw attention to the fugitive situatedness of dark matter as a shifting set of practices: one that can emerge in new fields of force as differing compounds.

When it uses landscape as a large-scale laboratory instrument, physics ventures outside its habitual zones. Jol Thoms uses signifiers of the laboratory and borrows tools of theoretical physics to trace and demonstrate this expansion. His aesthetic tools for thinking-making take this drive to extremes that might recognize the potentialities offered by rogue geographical assemblages. Thoms's work represents additional dimensions that might enable a multi-perspectival reframing or might contract them so matter that is imperceptible to one dimension might cast shadows in another (for example, three-dimensional shapes would appear as two-dimensional in flatland). Relevantly, Philip Tanedo and collaborators recently proposed that dark matter may be better understood as operating in a four-dimensional space with "dark" forces.[32] Seeing a fourth dimension would mean, for humans, seeing a three-dimensional object from all sides at once, and Thoms's sculptures, *The Bulk: Frameworks* (2021), are emblematic of his play with flattening and building out multi-dimensional views; the outlines of interlocking cubes made with angle steel seem to project shadows of further dimensions, interfering with each other in fascinating ways as the sculpture spins. Correspondingly, the crisp rotating floor shadows of the hypercube sculptures offer a re-flattening and surprising new legibility.

Riley seems to draw upon the desire of energy and the amorous transport beyond everyday existential territories that might heal bodies and reconnect with ancestors. Both of her works in the exhibition are

32 Iqbal Pittalwala, "A new dimension in the quest to understand dark matter," PHYS.ORG (2 June 2021), phys.org/news/2021-06-dimension-quest-dark.html.

material gifts to the future. They are, again, *differently physical*; one doesn't possess love like one allegedly possesses information, knowledge, or art. Both are sitting with the present-day untranslatability of certain cultural and disciplinary knowledge systems. In sitting so, among other things, they're modelling strategies for negotiating with colonial institutions by fostering unseen transformations that don't need to sacrifice to ideals of capture.[33] Given the anticipation of presence that conditions this project, it is easy to see the power of not presenting.[34] It is a form of cultural work in Riley's practice to reconsider prefigured acceptance within settler systems and the ways its rewards are valued. There are elements of refusal in Riley's work for *Drift*, alongside key moments of engagement. As carefully as she negotiated her presence in the residency, Riley negotiates it in the exhibition space through the conversational video piece, *the heart of the matter*. Riley's attention to dark matter physics is guided by the flux of identity and the ethics of responsibility learned from her mentors and from teachings of her relations among the Slavey Dene. Notably, Riley does not share the words for "I love you" in Dene itself. "It's sacred," she says in the video. She positions this love that is "invisible" but nonetheless "there," a gift of an allegory for dark matter, something present and unseen.

The scientific search for the "known unknown" of dark matter creates circuits of information, methods of enquiry, and material manifestations out of a wish for a direct experience. In *the heart of the matter* Riley gives a personal experience of something we might call Indigenous science: circuits of information, methods of enquiry, and material manifestations that are likewise born of a longing for an experience of presence. *the heart of the matter* decentres the framing of the residency in a way that focuses, rather, on the process of searching. At the same time, the piece takes advantage of its strategic opacity—the aspirations for love shared through secret and sacred language—and points toward zones ungovernable by settler art and science, and therefore imperceptible to some gallery visitors. It also demonstrates a strong independence that will not be instrumentalized, while deploying what Riley refers to as "radical softness" in its moments of engagement.[35]

Artworks and artists are unconsciously figured into the position of dark matter themselves during the residency; the artworks are often baffling, and the artists are perceived to embody alterity, to think and behave in ways that are beyond comprehension or prediction. Being considered dark matter can discount and disregard artists already marginalized through intersecting forms of social disempowerment. In other cases, such opacity-to-some is a useful position for artists; it preserves and generates the possibilities of freedom and difference.[36]

33 María Iñigo Clavo, "Traces, Signs, and Symptoms of the Untranslatable," *e-flux Journal* 108 (April 2020), e-flux.com/journal/108/325859/traces-signs-and-symptoms-of-the-untranslatable.

34 Refusal is a potent strategy for Indigenous artists who are approached with tokenizing and instrumentalizing invitations in contemporary culture. For a summary of approaches to refusal, see Jarrett Martineau and Eric Ritskes, "Fugitive indigeneity: Reclaiming the terrain of decolonial struggle through Indigenous art," *Decolonization: Indigeneity, Education & Society* 3, no. 1 (2014): i–xii; Audra Simpson, "On Ethnographic Refusal: Indigeneity, 'Voice' and Colonial Citizenship," *Junctures* 9 (December 2007), pages.ucsd.edu/~rfrank/class_web/ES-270/SimpsonJunctures9.pdf; and Eve Tuck and K. Wayne Yang, "Unbecoming Claims: Pedagogies of Refusal in Qualitative Research," *Qualitative Inquiry* 20, no. 6 (2014): 811–18, journals.sagepub.com/doi/abs/10.1177/1077800414530265.

35 Conversation with the artist.

A data readout from DEAP-3600, a dark matter experiment located underground at SNOLAB. Video: Zac Kenny

Opacity often contributes to the break, the central non-communication through which art communicates. For Félix Guattari, "With art ... the finitude of the sensible material becomes a support for the production of affects and percepts which tend to become more and more eccentred with respect to preformed structures and coordinates."[37] Art, too, is a "known unknown."

The confrontation with science and dark matter gives art a reflexive awareness of its claims to freedom. What frameworks must be in place for art to claim a kind of escape into what Amanda Beech calls "non-representationalism"? For Beech, art has claimed "privileged access to 'other' spaces and presented them as spaces of movement, time, duration, change, flexibility and mobility that were argued to be and go beyond conditions of global power."[38] I suspect that the habituation of a framing device normalizes the framer's claims to a kind of enclosure and related positionality. That is, being the one who does the framing or unframing is precisely the logic and the reward of framing's power. The unanswered question: How do art's claims as an autonomous form of knowledge participate in colonial appropriation and accumulation?

To frame is to scaffold, but also to cut. The etymology of science is "skei: to cut, split."[39] To return again to Foucault: "Knowledge ... is made for cutting."[40] Could we give dark matter a new name that describes something present and virtual, not rationally foreclosed nor mystified, an a-signifying matter passing through a paranoiac straitjacket? Since dark matter is present and yet nonfigurative, what if its name were pointing to vital heterogeneity rather than lack, latency, or ignorance? Pointing to the need for assemblages of enunciation, a people yet to come, that could forge new coordinates of analysis, could we call it "schizo-matter"?

Negative Vitality

Our use of the word "drift" in the residency and exhibition titles suggests a surrender to unpredictability or even delirium. Does art's claim to freedom of sensory invention and difference gain any purchase in its association with physics and dark matter? What erotics draw us into the singularity of dark matter? Art must trust its methods if it is to claim such complicated visibility in relation to science. Anne Riley's use of "dark matter" as a name for soil is revealing; it is a linguistic reclamation of the situatedness of the search for dark matter that draws on its poetic contact with a vitality.[41]

It isn't dark, having no relationship to visuality, but its name already carries a certain

36 Tarin Dehod, "Responsible Hearts: T'uy't'tanat-Cease Wyss and Anne Riley," *BlackFlash* 35, no. 3 (2018), 16–22. Emelie Chhangur's discussion of the right to opacity by way of the thought of Édouard Glissant was also influential here.

37 Guattari, *Chaosmosis: An Ethico-Aesthetic Paradigm*, 100–101.

38 Paul Stewart and Amanda Beech, "Non-Place and Movement: An Interview with Amanda Beech," *OnCurating Journal* 45 (April 2020), on-curating.org/issue-45-reader/non-place-and-movement-an-interview-with-amanda-beech.html#.Ys8rX-zP1UC.

39 Brian Holmes points out the common etymology of science and schizophrenia in Brian Holmes, "Guattari's *Schizoanalytic Cartographies*, or, the Pathic Core at the Heart of Cybernetics," Continental Drift (website) (2009), brianholmes.wordpress.com/2009/02/27/guattaris-schizoanalytic-cartographies.

40 Michel Foucault, "Nietzsche, Genealogy, History," in *Language, Counter-Memory, Practice: Selected Essays and Interviews*, ed. D. F. Bouchard (Ithaca: Cornell University Press, 1977), 139–64.

41 Anne Riley's work often takes pleasure in repossessing language. For example, Riley and Wyss called their cassette tape *Soundtrack for the Radical Love of Butterflies* and its launch a "release." See Banff Centre for Arts and Creativity, "If the river ran upwards," banffcentre.ca/if-river-ran-upward.

negative vitality. Dark matter has been given this particularly exhilarating misnomer for being such a reportedly mundane substance. The bundle of unconscious desires driving its semantic associations brings complexity to the particularity of the search for dark matter search. For example, a scopic regime locates an opacity in the encounter with the kind of blockages, limitations, and epistemological difference natural to the search for dark matter. Those attuned to the history of contemporary aesthetic practice can observe the privilege of the retinal in its use of "dark" in reference to imperceptibility. The visual is only one of the ways our perception falls short. We also cannot hear, smell, or identifiably touch sub-atomic particles. Dark matter is said to be matter that is invisible to the human eye, and obscure to radio waves, microwaves, infrared light, ultraviolet light, X-rays, and gamma-rays. It also does not appear to interact with an electromagnetic force. Yet, seeing is the favoured metaphor for knowledge, both as that which is revealed to sight and that which has been empirically proven; even if it is invisible to human perception, it is still "seen" by physics.[42]

It is the electromagnetic "blindness" to dark matter that opens broader sensory ways of knowing: indirect uses of sound or touch (the vibration of a crystal lattice in Super Cryogenic Dark Matter Search, for example) that are at work in SNOLAB.[43] The scopic regime operates equally in its "negatives," such as the mental image of artists and scientists deep underground elaborating an "undercommons" away from the pressures of the present upon our disciplines.

Still, a subversive, generative praxis of *mattering* dark matter must emerge through and against the grain (field of forces) of its over-coded name, even if it is to avoid naming. In her 2019 performance, *I am nameless*, Josèfa Ntjam looped her chanted poetic refrains towards what she called "infiltration and non-appointment."[44] In this piece, nameless infiltration is a "survival strategy" that allows racialized artists to resist entreaties to origins and other forms that (re-)racialize and foreclose polysemy. Enclosure can, she suggests, be subverted by keeping factors in tension, by keeping a space for creating in the dark. Could we live without naming, like Ntjam's narrator who intones "In the loneliness of collectivity I'm nameless!"

Artists are commonly aware of the composition of negative space in the composition of the positive, and some are no doubt suspicious of its binary construction. Dark matter commonly signals a lack, a gap in knowledge provoking a desire for detection that could be understood more productively as a site of affirmative desire. If the legacy of dark matter's name is haunting us, what spectral potency does it hold? What worlds can the name make? Can we give its nascent condition a new poetic value in relation to its frame?

Most kinds of light are invisible to humans; the energy of ultraviolet light that causes the liquid of *Luciferin Drop* to glow is too high for humans to see and it is only "out of

Anne Riley, *dark matter garden*, 2021. Photo: Tim Forbes

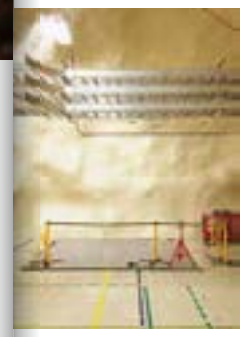


Photo: Jol Thoms

Nadia Lichtig, *Blank Spots (Reichstagbunker)*, 2017–2022, frottage on canvas, theatre lights, sound, scores, choral performance. Collection of the artist. Photo: Rachel Topham Photography

Nadia Lichtig, *Headless (Dark Matter) 1–5*, 2018–19, digital print, ink and charcoal on fabric. Photo: Toni Hafkenscheid

42 This is especially so in the case where it interacts with the electromagnetic spectrum. Can we say that we perceive something through its absence? Can we truthfully say that we perceive dark matter through mathematics?

43 "SuperCDMS | Super Cryogenic Dark Matter Search," Stanford Linear Accelerator Center (website), supercdms.slac.stanford.edu.

44 Ntjam, *I am nameless.*

band" leakage caused by the bulb's coating that one perceives. Dr. Arthur McDonald pointed out that Ntjam's use of blacklight in her sculpture shows how often "the perceived" seems to have an unperceivable source. All light is a cascade of forces whereby transmission and reflection may be caused by a "known unknown." Causality is another desire bundled into the individuation of dark matter. Quantum switch experiments give us reason to suspect that such assumptions of causality arise from human bias rather than nature.[45] That which we don't know how to know and which we don't know we can know have unclear causal relationships with what we can experience or theorize as energy or matter.

Ntjam's work in performance, digital collage, sculpture, and video offers us a conduit for the enunciation of anterior assemblages we narrativize as mythology, stories drawn from a rhythmic and poetic space of trance states, and speculation about the shapes of being. It offers the possibility to un-narrate or re-narrate science. The vessel *Luciferin Drop* appears in both sculpture and video form, carrying its glowing substance, a futuristic alchemical vessel shaped like a giant water droplet or glass beaker with human-like feet. The implied intra-action of the work's components suggests infinite speeds like those implied in quantum mechanics, whereby measurements performed on one system seem to be instantaneously influencing other systems entangled with it. Complicating easy causality, the vessel seems to be resting only temporarily on Earth, or at least it seems to have arrived at high speed and could leave as quickly as it came.

The desire for story, too, is bundled into the singularity of dark matter. Ntjam's video *Myceaqua Vitae* uses computer-generated imagery (CGI) and microscopic camera footage to present a poetic narration apparently spoken by an unclassifiable bioluminescent organism that seems to have come from outer space, birthed, she says, by "the thought of ancient water."[46] The visuals and narration describe a condition of hybridity inspired by a species that is neither plant nor animal. Like her digital collage work in the installation's circular carpet *Organic Nebulae*, the poetic intimates a kind of speculative kaleidoscopic abstraction that offers complexity to the ocularcentric binarism of contemporary culture and the name of dark matter. The artist mixes fragmentary references to dark matter physics with references to biology, chemistry, and alchemy: "Dig the earth to understand the stars, catch the light to detect the intangible," chants the narrator as we zoom into microscopic components of material. "Under the layers of metamorphic stones, I expressed myself, in binary figures, in luminous explosions that one tries to detect." Ntjam, who has described her own writing as "po(l)etique," a mix of "poetique and politique"[47] whispers, over a bed of music that seems to pay tribute to Detroit Techno.[48] The chant is an articulation of unceasing resilience, a vitality that resists capture: "I still escape the existence that was assigned to me." The piece

45 Natalie Wolchover, "Quantum Mischief Rewrites the Laws of Cause and Effect," *Quanta Magazine* (11 March 2021), quantamagazine.org/quantum-mischief-rewrites-the-laws-of-cause-and-effect-20210311.

46 Josèfa Ntjam, *Myceaqua Vitae*, 2020, video with sound. Collection of the artist.

47 Interview with the artist.

48 Drexciya is an important influence for Ntjam. See Albert Freeman, "A Guide to Drexciya's Futuristic Electro" (18 April 2019), daily.bandcamp.com/lists/drexciya-album-guide.

allows finite expression to manifest the presence of the infinite. In *I am nameless* she declared, "let the shapes of the universe express themselves!" Ntjam articulates a poethics of becoming-with intra-connected material realities outside of rationalized time.[49] Her work points to the way in which science is already inseparable from aesthetics and narrative, and she demands a new story, new worlds. In *Myceaqua Vitae*, Ntjam figures a protagonist through which art and science could re-figure agency.

Matter-Curious

There are at least two kinds of curiosity: major and minor. The major kind belongs to the nobler pursuit of knowledge by capital "S" Science and capital "A" Art. Anne Riley's work is often materialized in the honest articulation of questions. Early in the *Drift* residency she asked several respected scientists: "Why are you looking for dark matter?" The question had the clarity that could only be pronounced by someone unembarrassed by not knowing, unfettered by the assumptions that structure a discipline. The answers they gave were reasonable: the universal desire for incremental knowledge of nature, technological side benefits, etc. What characterized them in this moment was their institutionally conditioned self-evidence, which had made them functionally unquestionable. Riley's new question made the invisibility of their self-evidence visible.[50] Approaches to the limits of knowledge are a central concern of any project attempting to think with dark matter. But the concept of knowledge limits constantly drives an ontological assumption that there is a discoverable pre-existent. As the search for dark matter is motored by this construction, it continuously promises new knowledge. What ends does the promise pre-construct?

Minor curiosity, I propose, is always at work within science and art, stealthily migrating into unregulated transversal solidarities. Riley's "Why?" is a question about what curiosity can *do*. Theorist Perry Zurn opens a productive space for thinking such undisciplined curiosity, pitting its "affect of political resistance" against lofty or voyeuristic varieties of curiosity.[51] In the heart of Riley's "Why" question is action of becoming rather than assumption of ontology; it is akin to asking what can this inquiry or study allow us to be?

What modes of curiosity were active in the *Drift* residency's chiasmic zone of thinking-making? As we ventured outside of art's normal sphere—although not legitimately inside science—the artists seemed driven by practices of indisciplined connection-making.[52] This kind of curiosity distinguishes their work from a transgressive paradigm, whereby a critique of science would play out as

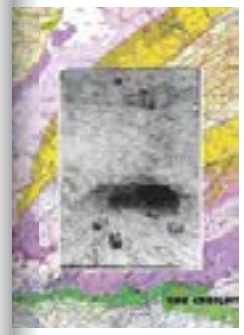
Artist Josèfa Ntjam delivers an artist talk to SNOLAB staff and the Drift: Art and Dark Matter team. Photo: Zac Kenny

49 Poethics is a concept introduced by Joan Retallack; see Joan Retallack, *The Poethical Wager* (Berkeley: University of California Press, 2003); it is further elaborated upon by Denise Ferreira da Silva in "Toward a Black Feminist Poethics: The Quest(ion) of Blackness Toward the End of the World," *The Black Scholar* 44, no. 2 (Summer 2014): 81–97.

50 Using Michel Foucault's formulation as quoted in Busch, "Artistic Research and the Poetics of Knowledge."

51 Perry Zurn, "Curiosity: An Affect of Resistance," *Theory & Event* 24, no. 2 (April 2021): 611–17.

52 In this *Drift* residency web call, Josèfa Ntjam discusses indisciplined connection-making; see "What is an art and dark matter residency?" Agnes Etherington Art Centre (website), agnes.queensu.ca/digital-agnes/online-exhibition/drift-art-and-dark-matter/what-is-an-art-and-dark-matter-residency.



Jol Thoms, *n-Land* (still), 2021, video, 5.1 sound, 17 mins.

a reactive position.[53] Without necessarily assuming inert facticity, ontology, scientific standards, identity, or classification, this kind of curiosity is nonetheless inspired by the liberatory possibilities of scientific propositions: neutrino phase oscillation, quantum entanglement, Baradian intra-action and mattering. Nor are the artists scientizing art.[54] Art and science both seem to show us what appears (or is becoming) beyond direct sensation, no doubt with different goals.

Riley's work takes contemporary practice into its uneasy edges; in *the heart of the matter* she takes it toward potent embarrassments of love. For Riley, vitality is a given: spirit's energetic material relations are alive in the world. Matter is an active space of change and potential from which we can have no strict separation. In conversation, she has responded to manifestations of the mechanistic model of matter with the question: "What matters?" Asking "What matters?" is to ask what or who is important, ethically. It is, equally, to ask who or what the agent is that is doing the mattering, to ask, effectively, "What matters us?" We ourselves are at once "mattered" and "mattering." Riley's work suggests, along with Karen Barad and others, that mattering is ethics in practice. Both of her projects, *the heart of the matter* and *dark matter garden*, seem to refuse to participate as expected and instead explore how we might practise mattering in a good way alongside other forms of agency deserving of respect. They both focus on the manners of becoming and practising a kind of art making approximating the caterpillar inside a chrysalis, or the future and past generations of plants carried inside a seed.[55] The works are seeking unseen love recovered for a people yet to come.[56] They model a rooted sense of care and self-care and a cautiously generous imagining, mattering of polyvocal future people.

Jol Thoms and Riley are inspired in different ways by Barad, a feminist science studies scholar who introduced an agential realism linked to the concept of "intra-action."[57] Barad's agential realism model arrives at the shore already reached by a much older Indigenous science. Leroy Little Bear and Sebastian De Line were also influential in the *Drift* residency.[58] Barad's philosophical provocation, aligned with Blackfoot, Haudenosaunee, and Anishinaabe perspectives, posits a more-than-reflective collectivity that extends relations

53 An apt reflection appears in Félix Guattari's *Cartographies Schizoanalytiques* published in 1989, which "goes beyond the critical perspective, suggesting how marginal groups acting on their subjective territories can put together experimental formations at the cutting edges of science and art, following the compass points of their intimate cartographies of desire." See Holmes, "Guattari's *Schizoanalytic Cartographies*."

54 Kathrin Busch writes that Foucault "expresses the clear-sighted fear that the scientifically institutionalized 'will to knowledge … tends to exercise a sort of pressure, a power of constraint upon other forms of discourse.' He refers to this will to knowledge that makes the arts seek to base themselves in science—'in short, upon true discourse' as a powerful system of exclusion." See Busch, "Artistic Research and the Poetics of Knowledge," 4.

55 Conversation with the artist.

56 Zepke, "The Readymade: Art as the Refrain of Life."

57 Whitney Stark writes in the *New Materialism* almanac that Barad uses the term "to replace 'interaction,' which necessitates pre-established bodies that then participate in action with each other. Intra-action understands agency as not an inherent property of an individual or human to be exercised, but as a dynamism of forces … in which all designated 'things' are constantly exchanging and diffracting, influencing and working inseparably. Intra-action also acknowledges the impossibility of an absolute separation or classically understood objectivity, in which an apparatus (a technology or medium used to measure a property) or a person using an apparatus are not considered to be part of the process that allows for specifically located 'outcomes' or measurement." Whitney Stark, "Intra-action," New Materialism: Networking European Scholarship on "How Matter Comes to Matter" (website) (15 August 2016), new-materialism.eu/almanac/i/intra-action.html. See also Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007).

58 Conversation with the artists. See also Dr. Leroy Little Bear, "Indigenous Knowledge and Western Science: Dr. Leroy Little Bear Talk," Banff Centre Talks, youtube.com/watch?v=gJSJ28eEUjI. The work of Anishinaabe artist and philosopher Dolleen Tisawii'ashii Manning is also an influence.

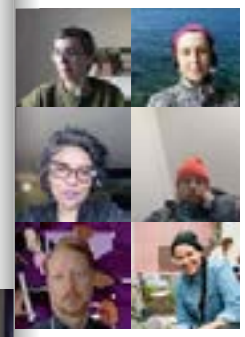
beyond the human.[59] A more-than-reflective paradigm would suggest that all parts of the Universe, including dark matter, give each other agency. For Barad, the paradigm is grounded in the *ungrounding* provocations of quantum mechanics, the stranger implications of which are not widely accepted in science. Thoms is interested in the agency of the Earth and the magic of the Universe.[60] His installation *n-Land: the holographic (principle)* suggests that science could understand the quest for knowledge differently if it took to heart the uncanny implications of its own theoretical speculation and movements beyond the lab.[61]

Among the implications of certain Indigenous and feminist models is the claim that stories themselves are agents that don't represent the world but create it.[62] Donna Haraway writes, "It matters what matters we use to think other matters with; it matters what stories we tell to tell other stories with ... It matters what stories make worlds, what worlds make stories."[63] *Drift* has been asking what world makes the story of dark matter. Haraway might ask what the story of dark matter does in the world? What can it do? If the Impressionists invented fog (which was there, but which we simply hadn't learned to see) what might the artistic speculation on dark matter do?

Affects that aren't yet fully recognized can be explored by art. However, affective sensations that seem to belong to geometries or temporalities introduced by art may seem delirious because they aren't yet recognized. Thoms's work looks almost like a science lab as it probes the visualities of science. At the most basic level, Thoms is interested in an immanent critique of Western science, meaning he doesn't separate himself from it but introduces difference and hybridity while being inside it. Thoms is finding art in science. He appears first as a documentarian, and to add complexity he borrows imagery, materials, and strategies of science. Thoms takes a diffractive approach that includes rather than isolates. *n-Land: the holographic (principle)* puts SNOLAB into the context of vast cosmic and geological time scales.

In collaboration with geographer Sasha Engelmann, Thoms wrote that particles lure "the Technosphere outside of itself."[64] Along with Barad, Thoms and Engelmann suggest that apparatuses of perception themselves are without clear boundaries and are inextricable from and productive of phenomena. Thoms is probing the possibilities suggested by science, but with a critical reading motivated by ecological concerns. He uses artistic effects of texture, rhythm, and experimental sonic composition. He connects large and small

Web-call with guest speaker Katherine McKittrick, joined by Michelle Bunton, Elvira Hufschmid, Sunny Kerr, Nadia Lichtig, Josèfa Ntjam, and Jol Thoms



Web-call with guest speaker Emelie Chhangur, joined by Michelle Bunton, Elvira Hufschmid, Zac Kenny, Sunny Kerr, Anne Riley, and Jol Thoms. Photo: Zoom

59 Cher M. Hill, "More-than-reflective practice: Becoming a diffractive practitioner," *Teacher Learning and Professional Development* 2, no. 1 (2017): 1–17.

60 Conversation with the artist. For a discussion of quantum mechanics and magic see Miguel Ferrero, David Salgado, and José Luís Sánchez-Gómez, "Quantum Mechanics and Magic: An Open Discussion," *HAL: open science* (2014), hal.archives-ouvertes.fr/hal-01057583/file/Q.M._and_Magic._An_open_discussion.pdf.

61 Deleuze and Guattari write, "if nature is like art, this is always because it combines these two living elements in every way: House and Universe, *Heimlich* and *Unheimlich*, territory and deterritorialization, finite melodic compounds and the great infinite plane of composition." Gilles Deleuze and Félix Guattari, *What is Philosophy?*, trans. Hugh Tomlinson and Graham Burchell (New York: Columbia University Press, 1994), 186.

62 Jerry Lee Rosiek and Jimmy Snyder, "Narrative Inquiry and New Materialism: Stories as (Not Necessarily Benign) Agents," *Qualitative Inquiry* 26, no. 10 (2018): 1151–62.

63 Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham: Duke University Press, 2016), 12.

63 Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Durham: Duke University Press, 2016), 12.

64 Sasha Engelmann and Jol Thoms, "Ve Vm Vt. The Ideal Cosmic Messengers," *Technosphere* (15 November 2016), technosphere-magazine.hkw.de/p/Ve-Vm-Vt-The-Ideal-Cosmic-Messengers-gTQ3sSabgSXLhFm2Hag5ny.

scales and attempts to think beyond them, sensitively crafting extended assemblages. He takes the implications of quantum mechanics seriously in broader aesthetic magnitudes, influenced by Karen Barad, Niels Bohr, Donna Haraway, and Isabelle Stengers. Science, for Thoms, is a broad and long kind of activity. He views science as if it is fortune telling, trying to do something magical, consciously taking it far afield of its mechanistic operations. Could we call this a practice of dark mattering in the sense that it is coming to new capacities? Do these come with or introduce new ethical bonds?

Riley's work is intent on transforming practice. Riley is interested in softening thresholds with strengthened trust. In her *dark matter garden*, the darkness and softness of the soil are vital for plants to take root. Read as a practice of mattering, it can become about loving oneself against colonial norms, accepting one's own force of movement in the diffractive space of ancestors and future generations. The work calls on us to consider our relationships with different modes of time.[65] Like Riley's search for Dene love, Josèfa Ntjam reaches toward anterior states of being woven precariously into time, states of being that impoverished forms of culture, myth, or religion fail to integrate. Ntjam recalls Sun Ra in searching for other worlds to come: "If space is the place," Ntjam says, "I'm ghostly-me, waiting for the rise of other worlds."[66] As the time travellers in her work make clear, if dark matter is obscure to perception, the occluded, oppressed past and possible future are also unknown terrains of potential.

Like each of the artists in their own way, Thoms's practice produces extensive space and time through a certain kind of anachronic layering.[67] If things appear to have dimension and time but are in fact encoded information, by constructing cross-dimensional projections Thoms creates intensities at the limits of perception.[68] Artworks are material-conceptual portals that can intimate the outside.

An experience of transient destitution marks Nadia Lichtig's works, where traces of a material, concrete history ground them. Lifted marks and layered fragments detach from indexical signification. Lichtig pointed out the slogan, "we guarantee disappointment," developed by the performance art group COUM Transmissions, which later became the pioneering noise group Throbbing Gristle.[69] Such disappointment is another way of saying the delirium that happens in artistic creation, essential to its multi-polar making and the gulf that separates it from its subsequent multi-polar reading, is worth infinitely more to art's operation and survivance than matching and achieving mainstream cultural recognition, communicability, or scientific legitimacy.[70] Art's failure to achieve realization, fulfillment, or possession, is not a hysterical

65 Dehod, "Responsible Hearts: T'uy't'tanat-Cease Wyss and Anne Riley."

66 Ntjam, *I am nameless*.

67 Through his prints and use of shadows, Jol Thoms speculates on how three-dimensional and higher-dimensional information might be encoded in two-dimensional space if we are to think of the holographic principle. His sculptures play with how four-dimensional space is encoded in three-dimensional space. Thoms's work is about ways of seeing that learn from science, but also trying to show new assemblies to science, including new views of itself in incomplete relations.

68 Jacob D. Bekenstein, "Information in the Holographic Universe," *Scientific American* (1 April 2007), scientificamerican.com/article/information-in-the-holographic-univ.

69 Email from the artist.

70 Franco Bifo Berardi, *Félix Guattari: Thought, Friendship, and Visionary Cartography*, eds. and trans. Giuseppina Mecchia and Charles J. Stivale (London: Palgrave Macmillan, 2008), 68.

self-definition; it is a confident assertion of its power. Non-discursive potentiality, the sequence of gasping and singing, is coordinated with the light beams over the frottages. Lichtig makes delirious reading. She pointed out the word "errance," which recalled the Situationist revolutionary strategy of the *dérive* (drifting). Art has the gift of the involuntary.[71] Sometimes it has to do with involuntariness, of looking away (like Anna Lowenhaupt Tsing's image of foraging).[72]

Toward a Physics of Residency

If experimentation defines both art and science as a narrative of process, *Drift: Art and Dark Matter* is its own sort of experiment. The *Drift* residency began with a proposition to connect contemporary art with the physics of dark matter at SNOLAB. The experimental prediction: artistic making-thinking could provide new routes for public access to scientific knowledge—even while pursuing affective ambiguity. It also proposed a second, more difficult, question of whether art could apply its own methods convincingly to the situatedness of the search for dark matter. More provocative still are the cartographic points we mark in the process of crossing disciplines with differing aspirations.[73] These emerged in the slowing process via discussion and through artworks and began to develop their own refrains: marking outsides sensible through earth and body, what frames are visible or invisible, what gets filtered out of art and science's prevailing models, Indigenous science and the continued colonial threats to its legitimacy and survivance, de-linking from extractive modes of habitual thinking within art and science, the possibility of being accepting of not knowing, speculation on radically decentred attractive forces that hold us together in cohesion across difference, and, finally, what it means to make the Universe more habitable. It is not merely that we make new portals, but we engender hybridities through reframing and estranging the Earth in multi-scalar, multi-centred, and multi-dimensional frameworks.

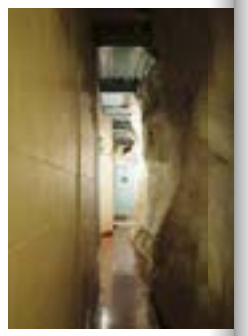


Photo: Jol Thoms

Dark matter is drifting through and past us, unrecognized and undifferentiated, opaque, and uncapturable. To practise dark matter would be to rest with unknowing and attend to the forces that enable collective agencies across constructions of the human and non-human. For Anne Riley, it is a radical love. The underground darkness of the drift and the isolation of SNOLAB's experiments provides, metaphorically, for rebirth and becoming differently. Here, we can trace the ways epistemological conflict may flow, not mobilized as a counterpoint within a Western understanding as a "benign otherness," but instead by introducing a process of creative cross-contamination.

SNOLAB provides an easy and seductive metaphor for isolation, purity, non-relation, abstraction, and context-blindness. Artists, scientists, and curator, neighbours in our urgent post-global moment, grasp a thinned and "weakly interacting" sense of solidarity. Art can offer apt accompaniment to physics by noticing and fashioning aesthetic connections to zones of imperceptible matter and beyond. In the translational space of a hybridity-to-come, the moments of disturbance or opaqueness can help us practise new ways of relating that might allow us to extend our imaginations. Trusting in art, we map out what might be the existence of a secret commons. Have we sketched recoverable routes toward such a space where the values of art and science might commingle, and where their co-presence is necessary? The border-crossing tendencies of art, at least, have put new relational singularities into wayward motion.

The results of artistic making-thinking and various disciplinary frictions have enacted this and other definitions of "drift." The varieties of isolation and sovereignty that are key for experiments in astroparticle physics (and, in a different sense, for contemporary art institutions) can become troubled by unruly tendencies within art. These tendencies include ambiguity (a missing matter of sorts) and ethical entanglements in the contemporary social context, which complicate notions of subjectivity, objectivity, or causality (as they are complicated in science).

Alongside the "known unknown," Nadia Lichtig, Josèfa Ntjam, Anne Riley, and Jol Thoms generate a superradiant surplus; the artists approach a kind of re-enchantment in constant hiatus where errant curiosities—underground and underburden—proliferate.[74]

Dark matter will always be a matter of anticipation and unknowing. Likewise, the drifting speculative rhetoric of this text must be considered as anticipating the moments produced only in the encounter with the work of art. Even if physics were to chip away at learning its inner workings through math and experimental deduction, dark matter will always be anticipated. It will never be grasped in the way gravity, time, or energy are even partially understood. While such anticipation of presence is our constant refrain, the obscurity of dark matter's avowed presence kicks off involutionary refrains that re-route and track entanglements across the self and other. These refrains feel for our own values in shared space and recognize our tensions, imbroglios, and inhumanity. They may also pursue lateral jaunts to attend to processes of transformation and figure out ecologically enmeshed ways of seeing and being. Here, forms of non-translation and poetic insight are allowed. Love and futurity: these are matters threading, circling, and stretching the frames of the physics of residency.

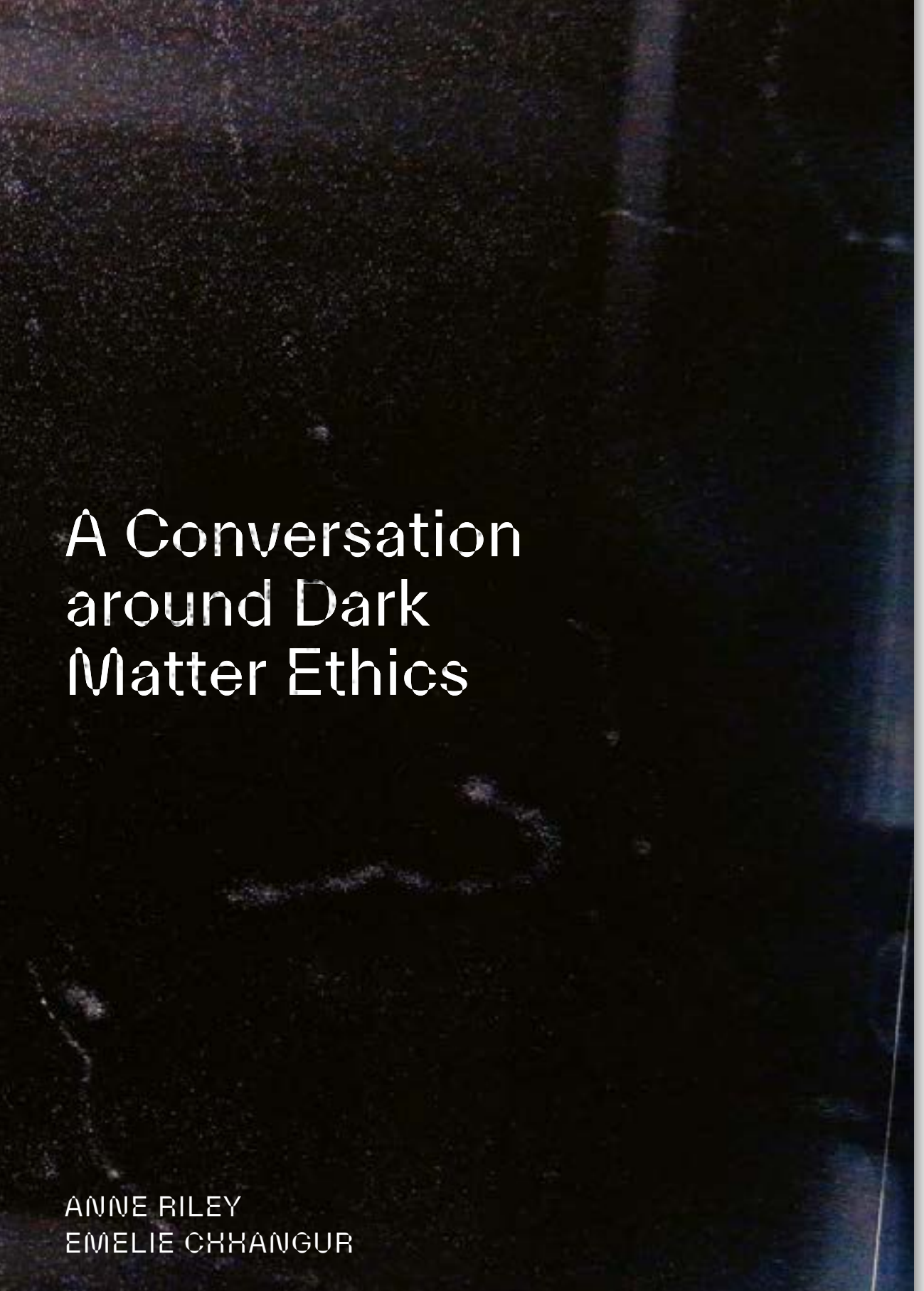
71 Busch, "Artistic Research and the Poetics of Knowledge."

72 Tsing, *The Mushroom at the End of the World*, 21.

73 Ben Eastham and Anna Lowenhaupt Tsing, "Anna L. Tsing on Creating 'Wonder in the Midst of Dread,'" *ArtReview* (29 November 2021), artreview.com/anna-l-tsing-on-creating-wonder-in-the-midst-of-dread.

74 I am indebted to Etienne Turpin for the gift of the neologism "underburden," through which he implies a metaphorical richness that shadows and escapes the predominating refrains carried by the mining term "overburden."

SUNNY KERR is a curator, artist, and writer. He is a settler of Scottish and Irish descent and Curator of Contemporary Art at Agnes Etherington Art Centre in Katarokwi/Kingston, Canada. He thinks with the provocations and potentials of art and the curatorial, and continually puts his work in reciprocal dialogue with inventive artistic thinking-making. Recent curatorial work includes projects with Sandra Brewster, Hadley Howes, Yam Lau, Ibghy and Lemmens, Tau Lewis, JP Longboat, Chris Kline, Ciara Phillips, Judy Radul, Walter Scott, and Jinny Yu. He studied art at Nova Scotia College of Art and Design and York University, and wrote his doctorate in Cultural Studies at Queen's University. Kerr fosters curatorial practice with graduate students by teaching in the Screen Cultures and Curatorial Studies program at Queen's.



A Conversation around Dark Matter Ethics

ANNE RILEY
EMELIE CHHANGUR

EC

EMELIE CHHANGUR: Anne, I'm really happy to be having this conversation with you. It feels very special to have an opportunity to talk with an artist whose work is dreaming into alternative practices—modelling otherwise practices—that art institutions can only aspire to because of their structural inadequacies. And I'm a director of an art institution who's trying to negotiate with its structure and transform it from within. I think these two processes—modelling alternatives and transforming from within—share similarities, but they're very different approaches to change. Often, one can dream of alternatives but get pulled back into the status quo and assimilated by it. And one can try to transform things from within, but really, you are always already trapped. So, it's a bit of a conundrum. But my work inside the institution is worth doing when I get to be alongside artists who are deeply engaged in world-making practices. I thought I'd start with a question, a very open question—a dark matter kind of question—that comes from two things I've been thinking about in relationship to your work. The question revolves around two ideas, both operational; one is related to the idea that *how* something is made will ultimately determine *what* gets made, and the other concerns how a practice "proposes." A practice can propose otherwise and a practice can propose the status quo. Both ideas are thus related to the *how of making*. And, so, my question to open things up is: What is dark matter as a practice?

AR

ANNE RILEY: Thank you for that question and those words. During my research for this project I was learning about dark matter and how according to western sciences dark matter is this invisible matter holding the universe together and so much of its properties are unknown to scientists. So when thinking about this I started from a place of reflecting on: how am I like dark matter? I did not seek to know dark matter from a western lens, but from a place where I was open to being transformed by the process of thinking and

being with dark matter. I was also thinking about myself as dark matter in the context of the art world and academia, as an Indigenous queer artist and how I'm often working within a system that is unable to see my practice; speaking to the kinds of emotional labour, but also the kinds of invisible things in my practice that are not visible to a system, a colonial system. For me, a dark matter practice is how I am centring nourishment for others and myself so that I can develop a sustainable way of being and making, and how I need to be strategic about the work I make and put into the world so as not to perpetuate extractive ways of making. And so, the practice, if I'm thinking of myself as dark matter, it is actually this very liberating way, I've found, to think of my practice. A kind of love ethic. I gesture to this practice in my video work *the heart of the matter* (2020) that is in the show. In the work, I am speaking about how differently it feels to say "I love you" in Dene rather than English and what somatically and philosophically shifts in my being when thinking about this. In the video, the shift is not performed for the audience, I never say the phrase, and that is strategic in that the shift I am speaking about is not consumable and for me this is a dark matter practising. Also, when I dream into this practice I encounter other dark matter beings within the art world, where my work becomes visible, I am visible to them, and we're able to see each other.

Yeah, amazing. I mean, there's something …—I did a quick Google search because I was, like, what is the first thing that is said about dark matter? It's that it is *undetectable*. On the one hand, it's super beautiful that it can be undetectable; it means dark matter can influence structures without being seen, without being verifiable. It does have a deep influence on our entire universe. But so much of what influences structures is also invisible. Dark matter is also talked about as being *undiscovered*. It's undetectable because it is opaque, but describing it as "undiscovered"

is problematic—there seems still to be the need to describe it in terms that are about ownership, transparency, discovery, and a kind of "unearthing," even though it's the cosmos! And it made me think about how one can operate in an invisible way that's super generative and expansive. It's more like setting something in motion than being the thing itself; more like *effects* rather than objects. Totally undetectable—until it's felt. Never objectifiable. I think that way around *dark matter garden* (2021–ongoing), for instance, and I wondered if, for you, this relationship to dark matter practice or dark matter being is a methodology—of being alongside, giving-on-and-with—of setting something in motion? And if so, how does one do that without discovering, exploring, and falling back into the traps set by forced intelligibility?

Yes, the western way of being that seeks to interrogate and extract is not sustainable, and it feels clear to me that dark matter does not want to be "discovered" in the ways western science is seeking to understand its being. Why can't we respect that it does not want to be "discovered" and its right to not be "discovered"? I think it's making in a way that … for example, *dark matter garden* is not in the gallery, it's not within the institution, it's outside. And so, because of the kinds of questions that I'm asking in that work, I don't trust the institution to be able to hold a space that I can address these types of questions in the work within the reductive framing of the institution's thinking. And so, for me, it's my desire to be outside of the limited ways of being and thinking of institutional framing. I desire to be asking questions in collaboration with the more-than-human—the other beings that I need to support. And asking those questions that I'm nourished by. And so, choosing to work outside institutional thinking, also, in a way, compels the institution to think outside of itself. And in a way that allows me to ask those questions in a place where there are witnesses. So the outcome is … there's accountability. During the making

and dreaming into the garden I was asking myself: what does it mean for me as an Indigenous visitor to be visiting someone else's territory and making art? And to not also, myself, perpetuate an extractive colonial practice of artmaking. Because *I went to art school*. I was taught how to extract and to make in ways that reinforce individualism and colonial ways of being. What ethics and protocols do I need in my practice so I do not perpetuate extractive practices? How will I be transformed by this work? How will the work ripple out beyond me? And so, I had to figure out how to explore these kinds of questions when institutions don't even want to touch that or speak of it. These things are so close to my heart, these questions and practices. Because, for me, it's in a large part based in ethics. How can I make in a way that I'm not extracting, not only from myself but from others, from the more-than-human? And then, in making work, how can I nourish not only myself but others? And dismantling this notion of "it's about me" or that I'm some kind of … I have a brilliant idea. And so, really, I'm just trying to dismantle that. I'm thinking alongside dark matter, with the dirt and compost that we put down in front of Agnes Etherington Art Centre, and strategically choosing not to plant, and not to dig up the land because, again, for me, it was not my place to do that. So the first step was reaching out to the Elders at Agnes and having conversations about my intentions. Deciding not to plant was trusting that if I just put down something that nourishes the dirt, I'm not imposing what I think should be there, but just nurturing what is already there. For me, this gesture is a metaphor, one that echoes dark matter. Like dark matter, what is there will make itself visible. And even the things that don't become visible, the plants, or the things that I can't see, such as the insects that I trust are there, are still being nourished. I don't need to see them to feel like this is successful and that it will be changing and evolving and drifting because the wind will bring in things, the animals will bring in different things. So this is kind of a beginning of … I continue to think with *dark matter garden* while acknowledging that the garden has its own secrets that I don't need to know. I don't need to possess them.

I really loved how you started your response with reference to the "kinds of questions" you are asking in the work. I also think you're asking these questions *with* the work. And I don't mean alongside the work in this instance. I mean, like, the work enacts the question itself. And so, it's a sort of dialogue you have with the work's *work*. Which I think is also about dismantling the notion that an artist's relationship to their artwork is one of authorship or ownership. As if an artwork is a "product" made by an artist. That creates a very particular kind of viewership which often results in questions like: "What was that artist's intention?" But you seem to completely avoid those trappings by setting the conditions in place for the work to do the work. And, in a way, that's … well … the best thing a viewer could ask is, how do I do this work?

The work is modelling. It's modelling—bear with me here—a practice of an *ethics* of dark matter. Every artwork has an ethic. Every institutional practice has an ethic. You make the ethic the work to be done. *dark matter garden* is not necessarily the artwork, it's the ethical work to be done.

If you know what I mean?

Mm-hmm.

Mm-hmm.

Exactly. It's more of … it's more of a question. It is the work of figuring out what kind of gesture is needed here to shape the questions that I'm sitting with that are so close to my heart. And what keeps coming back? What is not leaving me? And so it is through a process of thinking with that and paying attention to that that I'm developing a space where I'm able to attune to and give space to the urgent questions within me. Because they aren't particularly special to

EC

And *how* is it educating?

And, well, I don't know exactly, but I can imagine, it's the joy of asking questions without prescribed answers.

AR

me, you know. They're not. In some ways, I'm kind of asking those questions because how can you not feel a sense of urgency about certain things? What is within *you* that is refusing to ask these questions? And so with *dark matter garden*, how do I make a gesture that is both nourishing and not didactic? The work doesn't solve the problem, but it opens a portal to be able to talk about it. To talk about what we don't want to talk about in the sense of, you know, why is this university here? What is it doing? Who is it serving? Who is it showing within its walls? Who is it educating? Who's missing?

How is it educating? Yes, what is it teaching? So, for me, a pedagogical question within *dark matter garden* is: Why are we only nourishing humans here? You know? What other questions are we not asking? And *dark matter garden*, I think, is doing its own teaching and shifting because new plant life is coming out right now. Everyone at Agnes is telling me that when they look out of their office windows they see a whole circle of dandelions, which I didn't expect to happen. And so, it's like the garden brought the sun out and it's offering that teaching in the sense of asking: what is lightness? Where is the sun? So these could be quite abstract questions, but I think *dark matter garden*, for me, is quite clear. How is the garden teaching me? So choosing the unpredictability in this gesture rests with not knowing what it would become or how it would shift. It was, for me, through the gesture that at least I knew I could … I could find the joy in asking questions that were quite private. And how could I share them and the dark matter? I find lots of joy in how the garden is evolving and revealing itself. I learn from what it wants to reveal. And that, to me, is the work.

EC

Not interpolative in any way. The garden doesn't … use an aesthetic language or principle that is already answering the questions it needs to ask. And its questions evolve as the air shifts or the weather changes.

Or, you know—how it bends when somebody passes by it. I see people coming toward it and they're curious. I mean it is already doing something special by being situated within a banal landscape, surrounded either by built limestone structures that have incarcerated the energic liveness of limestone or a well-manicured lawn that has trapped the grass. So *dark matter garden* already attracts. It is also, of course, part of an ecology attracting all kinds of more-than-human forms and entities, and they're doing their thing without the need for any further cultivation. But *dark matter garden* attracts humans and the curiosity of difference—toward difference. When these humans approach it, there's like a sort of forcefield around it because they're not going to, like, pass right through it. So, it's quite interesting to witness the questioning that is taking place by its very presence on this manicured lawn. It is questioning the manicured lawn, too, but without that being the subject, or main focus, of its inquiry. So, when you said it doesn't solve the problem, I would add, it also doesn't critique it.

dark matter garden's energies are not spent critiquing something that it is never going to solve; or, put another way, that it needs to care about. It already recognizes its work is doing something else, that maybe isn't about solving a problem. That's another thing I think the art world thinks art does. Many believe artworks can be used to solve problems. And that runs the gamut from social practice which presumes it's

AR

Exactly.

Mm-hmm.

Mm-hmm.

EC

solving a social need, to Conceptual art which centres on solving abstract philosophical questions. So, I also think *dark matter garden*'s refusal to critique and thus participate in systems that are no longer necessary, is also its *secret power!*

AR

Yes. Thank you for saying all of that because that is exactly … What you just articulated feels so true for me. And I think you just expressed something that … I really appreciate how you outlined the difference between not solving the problem and not participating in critique. I think when you offer an alternative to conventional aesthetics or to extractive practices, maybe it's not fully critiquing but showing what is being done and what isn't being done. And it doesn't exhaust me in doing it, and that's why, for me, it's so close to the process of thinking with dark matter. Since this system is not able to see certain things, how do I work from a place that gestures toward or offers an intervention, an alternative, in a place that otherwise doesn't see me or these questions?

EC

So, you are working deeply from a place of freedom because the undetectability also is freeing?

AR

Mm-hmm.

EC

I mean, like, sure, if I'm not seen in these systems, that's rage-inducing. But there's a space of freedom in the ability to be undetected.

AR

Mm-hmm. Exactly.

EC

And then all of a sudden something shifts. To be undetected is also to create the conditions to do work *otherwise*. Because if you are detected, you get shut down. Like, there are all kinds of restrictions around why something can't happen but rarely encouragement for yet-to-be-known potential.

AR

Exactly.

EC

The negotiations for *dark matter garden* were likely related to its situatedness, as if it's interpreted as an Earthwork, for instance: whether we can do this work on the front lawn of Agnes. That's a kind of administrative negotiation for permission one makes to site the work and is thus outside of the work's work. *dark matter garden* doesn't have to ask for permission, not for all of the other things it enacts because those things are not intelligible and don't actually require a discussion with the institution.

AR

Yeah. The video work, *the heart of the matter*, was also making in a way where I'm not needing to … yeah, thinking with what you just said, the freedom of being undetected. You just started to, once again, articulate something so true to how I feel in this work and the things I'm thinking through. Because there isn't a bunch of noise in the sense of … I'm taking up space, there are a ton of objects and aesthetics in the work, and they're read through a certain lineage of artmaking. They're quite bare. They're quite clear. And, for me, these things can be read as kind of strange in a way. Especially *the heart of the matter*, where I'm speaking about what it means to say "I love you" in my Dene language, compared to when I say it in English, and what philosophically shifts in my body. But I never say the phrase. So is that the work? What is the work? It can be read in so many different ways, depending on who's viewing it. An Indigenous person is going to view that work and those questions quite differently than a non-Indigenous person. And so, even though it's … yeah, it's undetected … it's undetectable to viewers. And that is what I enjoy in the video. Because I also make work for, you know, Indigenous people so we can detect each other, so we can see each other in the work. I see you!

the heart of the matter's ability to find its community isn't through consumption in the sense that what shifted are the energies. That is what makes the work detectable to other dark matter beings.

EC

That's what's alive in this video, through your address. The video is an outward expression of that inward shift. And it's evidence of that, but that evidence is not intelligible to someone who doesn't share the same sense of feeling. So, you're operating totally on this level of, well, feeling. Even if it's mediated through video, there is a direct sense of shared energy. But there's something else also—I mean, in the show it's like dark matter, it infiltrates and shifts the scene; other than maybe seeing some figures in labs, or background activity in other videos, perhaps, your video is the only human presence that is addressing humans in the exhibition. And that address isn't intellectual, it's emotional.

It seeks intimacy. It pierces through what is a sort of un-personable exploration of dark matter.

It's not explored scientifically. You're not getting at dark matter. At the end of the day, you got to the *heart* of the matter. You've *inhabited* the heart of the matter. Or the heart is inhabiting the possibilities of mattering otherwise?

... how dark matter was operating for us.

AR

Right, yeah ...

Mm-hmm.

Yes. That's beautifully said. I've enjoyed how our conversations throughout this project have impacted me. It's not often I feel as seen in my work as I have during our conversations, and I deeply appreciate the ways you are able to see the gestures. I've deeply enjoyed the conversations we've had around my work at Agnes, and the universe and the cosmological reality of you coming in as the new director right in the middle of this project. Yeah, I've deeply appreciated how things ...

Definitely.

EC

Thank you, dark matter!

No, I have to say—I'm not even kidding, because I feel like it was—I was super fortunate that we were brought together through this at a time when I had just arrived, too. And, you know, it was not an easy arrival; it was quite difficult. For example, *the heart of the matter* was just so beautiful and intimate and actually made me think differently about the role and function of the Samuel J. Zacks Gallery at Agnes. The work made me think about that gallery as a space of somatic orientation for the viewer. It made me more aware of how an artwork can attune a viewer to a way of thinking and experiencing an exhibition without language, as a performative didactic, perhaps. So there was that. But the *dark matter garden* lives with me all the time at Agnes. And I don't mean it just by, like, looking at it from my office window. I mean it really is—teaching. It's informing a reimagining of Agnes. And even informing what kinds of new architectures might be built for Agnes Reimagined[1] that don't trap, contain, or conceal. Not a fortress. Like, how could an architecture do what *dark matter garden* is doing in its very form? The architecture would be a proposition, not a container.

AR

Yes.

Yes, *dark matter garden* is evolving, along with your work at the Agnes since you've begun, and the possibility of what is being reimagined at that institution. I look forward to seeing the possibility of what is to come and to *become*. Because that garden—*dark matter garden*—is an invitation for the institution to engage with it in a way that reflects a willingness to change and an openness to learning from it. When you came into the position at Agnes, I felt good about doing this work knowing about your approach to art and thinking and making. I thought this person might be able to engage with these questions, and we might be able to approach them together and engage with

1 Emelie Chhangur, "Agnes Reimagined," Agnes Etherington Art Centre website, agnes.queensu.ca/connect/news-and-stories/agnes-reimagined.

EC

It compels us to insist upon growth and change as a strategy and as an alternative to fixing and stasis. And if that … if dark matter gave us that, dark matter has brought this constellation of thinking together and I feel very fortunate and happy for it.

Who can we bring into our constellation next?

I think we did a good conversation? Should we …

Okay. But I don't want to, like, just exit the Zoom then not see you. So I'm going to stop and then I think I'm going to exit because I want to make sure that this thing worked …

And then can we jump back on just to say goodbye?

I'm going to stop now.

AR

other folks in a broader sense. I have deeply enjoyed the continued conversation and exploration that I don't find very often at institutions. So, I thank you for that. And thank you for the ways in which I feel seen in this work.

Yes. I look forward to seeing how the constellation grows.

Yes.

I think that's good.

[inaudible] … get your file.

Yeah, definitely.

Okay.

This conversation has been edited for length and clarity.

ANNE RILEY is a multidisciplinary artist living as an uninvited Slavey Dene/German guest from Fort Nelson First Nation on the unceded Territories of the Musqueam, Squamish, and Tsleil-waututh Nations. Her work explores different ways of being and becoming, touch, and Indigeneity. Riley received her BFA from the University of Texas at Austin in 2012. She has exhibited both in the United States and Canada. Currently she is working on a public art project commissioned by the City of Vancouver with her collaborator, T'uy't'tanat-Cease Wyss. Wyss and Riley's project, *A Constellation of Remediation*, consists of Indigenous remediation gardens planted throughout the city, decolonizing and healing the dirt back to soil. The duo was included in the longlist for the 2021 Sobey Art Award.

Over the past two decades, curator, writer and artist EMELIE CHHANGUR has emerged as a leading voice for experimental curatorial practice in Canada, celebrated nationally and internationally for her process-based, participatory curatorial practice, the commissioning of complex works across all media, and the creation of long-term collaborative projects performatively staged within and outside gallery contexts. Chhangur is currently Director/Curator of Agnes Etherington Art Centre, where she fights for a community-engaged architectural design process to reimagine new museum architectures that ensure cultural spaces of Canada's future no longer look like those of Canada's colonial past. This work follows a significant curatorial career at AGYU, where she led the reorientation of AGYU as a civic, community-facing space driven by intersectional collaboration, founded the artist residency program, and received 25 Ontario Association of Art Galleries (OAAG) Awards for contributions in writing, publishing, exhibition-making, public and education programming. Dedicated to questioning the social and civic role of the public institutions of art, Chhangur has developed a curatorially-engaged approach to working across cultural, aesthetic, and social differences through a practice she calls "in-reach." In 2019, she won OAAG's inaugural BIPOC Changemaker Award and in 2020, the Hnatyshyn Foundation Award for Curatorial Excellence.

Uncertain times have passed since the appearance of this coagulated luminescent substance. From the encounter of a mycete and *luciferin* carried by a sea thought. The strange story of a starfish that fell from space, which with its limestone nourishes the oceans.

Des temps incertains se sont écoulés depuis l'apparition de cette substance luminescente coagulée. De la rencontre d'un mycète et de *luciférine* portée par une pensée de mer. Étrange histoire d'une étoile de mer tombée de l'espace, qui de son calcaire nourrit les océans

Myceaqua vitae, luminescent organism that escaped volcanic rock, while the Earth was not yet the planet that bears its name. Crawling network of algae that came from the abyss's depth and a gluey mushroom. The myth says that its heavy water would have found in itself some particles of a world where light has been absorbed.

Myceaqua vitae, organisme luminescent qui se déroba à la roche volcanique, alors que la terre n'était pas encore celle qui porte son nom. Réseau rampant d'algues venues du fond des abysses et d'un champignon gluant. Le mythe dit que son eau lourde aurait trouvé en elle quelques particules d'un monde où la lumière aurait été absorbée.

Overflowing cell, it does not stop; even while crawling, it continues to advance. Rock eater, decomposition of our thoughts into undulating rhythms, it transformed stone into earth. *Myceaqua vitae*.

Cellule à débordement, elle ne s'arrête pas même en rampant elle continua d'avancer. Mangeuse de roche, décomposition de nos pensées en rythmes ondulés, elle transforma la pierre en terre. *Myceaqua vitae*.

It is in the infinitely small of a sprawling network, in perpetual motion, that the ocean spoke to space and the marshes to volcanoes. Water turned stone into earth and propelled the molecular alchemist into space.

C’est dans l’infiniment petit d’un réseau tentaculaire, en perpétuel mouvement, que l’océan parla à l’espace et les marais aux volcans. L’eau changea la pierre en terre et propulsa l’alchimiste moléculaire dans l’espace.

Packaged, freeze-dried memories during an abstract dream. Souvenirs are too dense to be caught. “If I could have placed the world in a vacuum,” she says, “it would still have expired.”

Mémoires empaquetées, lyophilisées au cours d’un rêve abstrait. Les souvenirs sont trop denses pour les attraper. Si j’avais pu mettre le monde sous vide dit-elle il aurait quand même périmé.

“If I could have placed the world in a vacuum,” she says, “it would still have expired.” *Myceaque vitae*.

»Si j’avais pu mettre le monde sous vide dit-elle,« il aurait »tout de même périmé«. *Myceaque vitae.*

But there will always be a drop of water to last longer than any chatter, delicate infiltration of an abstruse world.

Mais il y aura toujours une goutte d’eau pour durer plus que les boniments, délicate infiltration d’un monde abscons.

I gave the humans some riddles to search for, to get them out of the boredom of a world too big for them to swallow. *Myceaqua vitae*.

J’ai donné à l’humain quelques énigmes à chercher pour le tirer de l’ennui d’un monde trop grand pour qu’il puisse l’avaler *Myceaqua vitae*.

Feet pushed me, and a crystalline envelope encompassed me. *Myceaqua vitae*.

Des pieds m’ont poussé, et un enveloppe cristalline m’a englobé. *Myceaqua vitae*

Dig the earth to understand the stars, catch the light to detect the intangible, and search the stone to listen to the universe and its incessant movement.

Creuser la terre pour comprendre les étoiles, attraper la lumière pour déceler l’impalpable, et fouiller la pierre, pour y écouter l’univers et son mouvement incessant.

I am only one clue among many, and I have let myself be rocked by an ocean of lava.

Je ne suis qu’un indice parmi tant d’autres, et je me suis laissée bercer par un océan de lave.

Under the layers of metamorphic stones, I expressed myself, in binary figures, in luminous explosions that one tries to detect. I still escape the existence that was assigned to me.

Sous les couches de pierres métamorphiques je me suis exprimée, de chiffres binaires, en explosions lumineuses que l'on tente de détecter. Je m'échappe encore à l'existence que l'on souhaite me donner.

Crawling, dripping. If I could have placed the world in a vacuum, it would still have expired.

Rampant, dégoulinant. Si j'avais pu mettre le monde sous vide, il aurait tout de même périmé.

So I traced the constellation of night-worlds swallowed up by dark matter. From uncertainties to uncertainties, people advanced toward me, seeking to deploy unacknowledged worlds.

Alors j'ai tracé la constellation des mondes-nuits avalés par la matière noire. D'incertitudes en incertitudes on avança vers moi, dans l'idée deployer des mondes inavoués.

I escape it all while crawling.

Je m'échappe tout en rampant.

JOSÈFA NTJAM is an artist, performer, and writer whose practice combines sculpture, photomontage, film, and sound. Gleaning the raw materials of her work from the internet and books on natural sciences, Ntjam uses assemblage—of images, words, sounds, and stories—as a method to deconstruct the grand narratives underlying hegemonic discourses on origins, identity, and race. Her work weaves together multiple narratives drawn from investigations into historical events, scientific functions, and philosophical concepts, which she confronts with references to African mythology, ancestral rituals, religious symbolism, and science fiction. These apparently heterogeneous discourses and iconographies are marshalled together in an effort to re-appropriate History while speculating on not-yet-determined space-times—interstitial worlds where systems of perception and the naming of fixed (id)entities no longer operate. From there, Ntjam composes utopian cartographies and ontological fictions in which technological fantasy, intergalactic voyages and hypothetical underwater civilizations become the matrix for a practice of emancipation that promotes the emergence of inclusive, processual, and resilient communities.

Ntjam was born in 1992 in Metz, France, and currently lives and works in Saint-Étienne, France. She studied in Amiens, France, and Dakar, Senegal (Cheikh Anta Diop University), and graduated from the École Nationale Supérieure d'Art, Bourges, France (2015), and the École Nationale Supérieure d'Art, Paris-Cergy, France (2017). Solo and duo exhibitions include: *and we'll kill them with love*, cac-La Traverse, Alfortville, FR (2022); *Molecular Genealogies*, NıCOLETTı, London, UK (2021); and *Allegoria*, a duo show with Kaeto Sweeney, Hordaland Art Center, Bergen, NO (2019). Her work and performances have been shown in international exhibitions, including: *EUROPA, Oxalá*, a three-part exhibition at Mucem, Marseille, FR (2021); Foundation Calouste Gulbenkian, Lisbon, PT (2022); and Musée royal de l'Afrique centrale / AfricaMUSEUM, Tervuren, BE (2022–23); *MEMORIA : récits d'une autre Histoire*, Frac Nouvelle-Aquitaine MÉCA, Bordeaux, FR (2021); *Anticorps*, Palais de Tokyo, Paris, FR (2020–21); *La Manutention*, Palais de Tokyo, Paris, FR (2020); *Paysages alentour*, Centre Pompidou, Paris, FR (2020); *Risquons-Tout*, WIELS, Brussels, BE (2020); *Climate Knowledges*, MAMA, Rotterdam, NE (2020); *15th Biennale de Lyon*, MAC Lyon, Lyon, FR (2019); and *Still I Rise: Feminisms, Gender, Resistance – Act 3*, Arnolfini, Bristol, UK (2019). Upcoming exhibitions include *Emotions Are Oceans: Bringing Water to Life in the Encroaching Desert*, Radius CCA, Delft, NL (2022); *Breaking Water*, Contemporary Arts Center, Cincinnati, US (2022); *Open Space*, The Photographers' Gallery, London, UK (2022); and *Les Portes du possible. Art & science-fiction*, Centre Pompidou, Metz (2022). Ntjam is also a member of the Paris-based art and research collective *Black(s) to the Future*.

Nadia Lichtig, artist

I'm driven by the conviction that we belong to an infinite universe (pause) a space governed by cosmological forces (extended pause) This connection between the living and the cosmos and its forces is something concretized in our bodily memory (pause) which is not always directly accessible to our consciousness (extended pause) Cosmic forces govern our sensory conditions (pause) but they are often invisible (extended pause, clack of the tongue) For instance (pause) we do not see or feel directly the neutrinos coming from the sun and constantly passing through our bodies (extended pause) I work to create objects with sensory qualities that lead us to a "counter-intuitive" sensory awareness (pause) in order to recognize the bonds that unite the living (extended pause) with what we perceive as inanimate (extended pause) of what we are and what constitutes us (extended pause) The emergence of a sharpened sensitivity to the biological and chemical conditions of life (pause) that the mineral (pause) the vegetal (pause) and animal worlds are one entity (extended pause, clack of the tongue) and an entity (extended pause) constantly transforming (extended pause) may help us to reconsider (pause) the frontiers we draw between the animate and inanimate (extended pause, rising of the voice) As the astrophysicist Art McDonald pointed out (extended pause, clack of the tongue) all that is surrounding us (pause) is made of stardust (extended pause) of extraterrestrial stardust (pause) the whole world is made out of dust (pause) dust from outer space (pause) including ourselves (extended pause, rising of the voice)

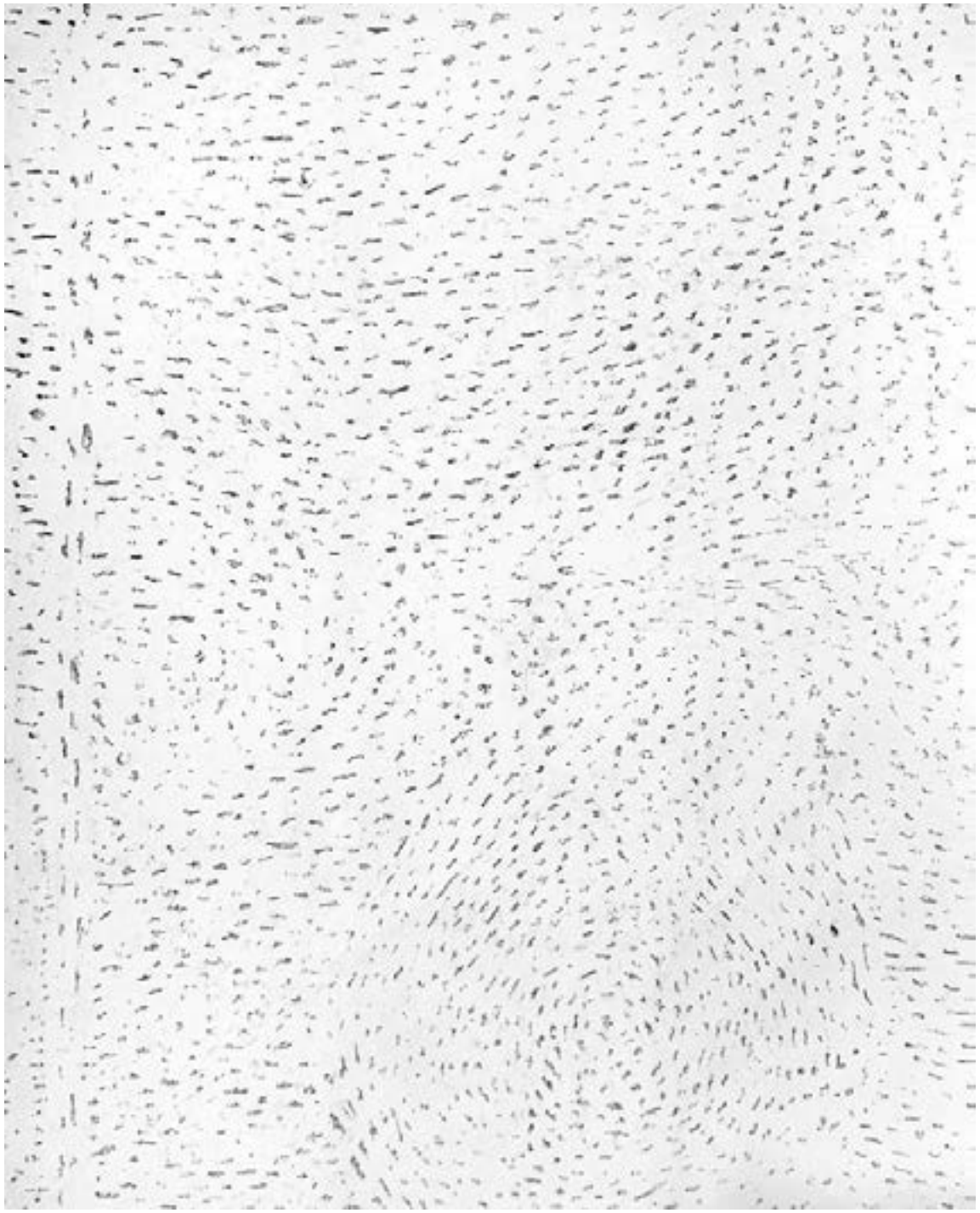
NADIA LICHTIG is an artist currently living in the South of France where she is professor for painting, experiment, and sound at the Montpellier Academy of Arts (MOCO Esba). In her multilayered work, each series is approached as a continuum of interwoven vocal and pictural gestures, which places experiential and conversational value at the centre, making visible the dynamic and vulnerable nature of the act of perception, and questioning our ability to decipher the present. By taking the interstice, the interval and the void as an element, the works of Nadia Lichtig invite audiences to think the crack, the missing image and the perforated structure of language, leading to the question: would not the only important image be the one which cannot be completed? Isn't any representation, any image, above all, witness to what it does not show, to what it excludes from our field of vision? Lichtig's work is regularly exhibited internationally. Several works have been acquired by public and private collections. She has received grants and residencies from, among others, the Goethe-Institut, Hanse Wissenschaftskolleg, an the Institut Français. Lichtig's work is represented by the Gallery Anne+, Paris.

Blank Spots is a series associated with events of history and national trauma. *Blank Spots (Reichsbahnbunker)* are frottages of street addresses in Berlin city around the Reichsbahnbunker, which was built in 1942 by prisoners of war. The frottages have been made in two different manners: cleaning the surfaces of these grounds with cleaning liquids on canvas and by imprinting the structures of these grounds on site with graphite on canvas. I consider the frottages to be cartographies that, as precisely as these events are historically rooted, and that concentrate the dust on the surface of this trauma, buried in the ground.

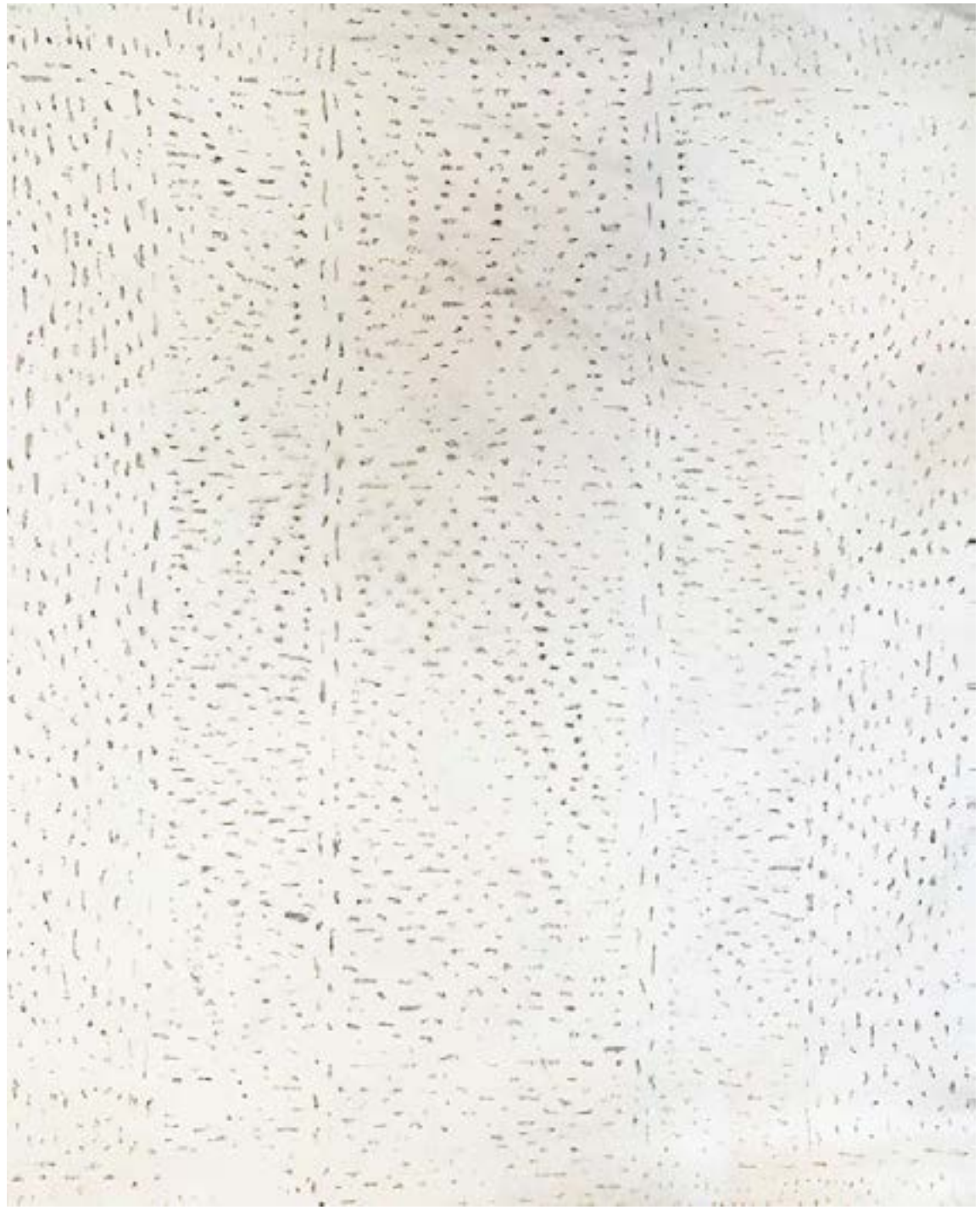
Nadia Lichtig, *Blank Spots (Schumannstrasse 8, Berlin) #1*, 2017, cleaning liquids and dust on canvas, 160 × 170 cm

Nadia Lichtig, *Blank Spots (Albrechtstrasse 25, Berlin)*, 2017, cleaning liquids and dust on canvas, 160 × 170 cm

Blank Spots consists of a series of frottages from which scores are derived. *Blank Spots Scores* are drawings combined with texts, superposing photographs of one of the frottages each. Occasionally, live or in recording, a composition for one to six voices based on the scores is to be heard within the installation. The frottages are lit with theatre spots guided by the sound of breath: the variations of the sound determines the intensity and rhythm of the lights, constantly varying the perception of what is to be seen.

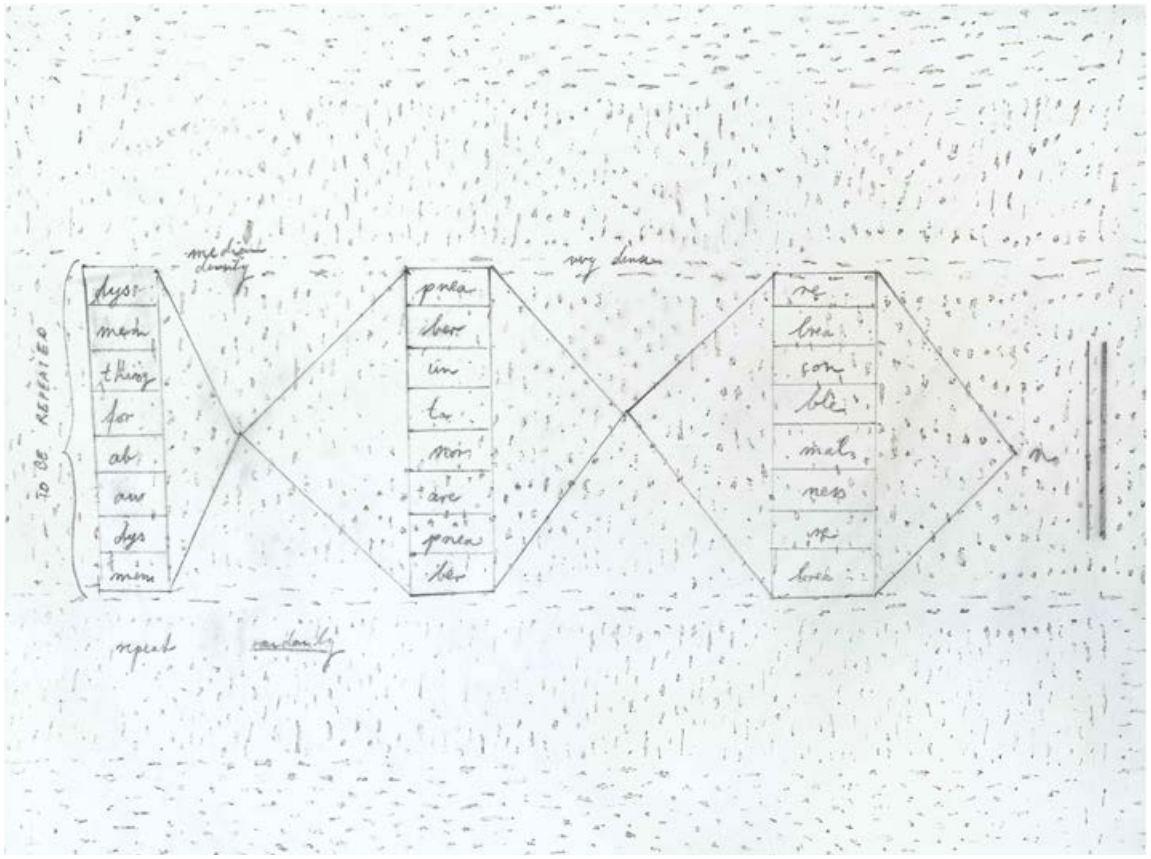


Nadia Lichtig, *Blank Spots (am Circus, Berlin) #1*, 2021, graphite on canvas, 160 × 170 cm



Nadia Lichtig, *Blank Spots (am Circus, Berlin) #2*, 2021, graphite on canvas, 160 × 170 cm

Blank Spots Score is a musical notation drawn from the frottages. At times, within the installation, songs can be heard, recorded or live as a choral performance. The score of these songs, one for each canvas, are displayed as stacks of photocopied letter format sheets, which can be taken with for free by the spectator. The texts are collected notes, reflections on dust, breath, stars, science, memory and oblivion. The score is to be interpreted as a choral performance for one or more voices.



Nadia Lichtig, *Blank Spots (Reichstagbunker) Score*, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers

Dyspnea is an uncomfortable abnormal awareness of breathing. A number of different sensations experienced by patients are probably included in this category. Dyspnea is the most common cause of respiratory limitation of activity in patients with pulmonary disease.
Dyspnea is a subjective symptom reported by patients. It is always a sensation expressed by the patient and should not be confused with rapid breathing (tachypnea), excessive breathing (hyperpnea), or hyperventilation. Dyspnea is most frequently described as shortness of breath, inability to take a deep breath, or chest tightness.

The quantification of dyspnea is also important in judging the severity and prognosis of the underlying disease. Dyspnea may be the limiting symptom and may be responsible for economic and social disabilities. Because dyspnea, like pain, is a subjective symptom, it is frequently influenced by the state of mind of the patient. In spite of this, in most patients a very good association exists between the severity of the underlying disease and the complaint expressed by the patient.

Although no physical findings directly relate to the complaint of dyspnea, several things may be seen in dyspneic patients. Dyspneic patients frequently breathe rapidly and shallowly. The accessory muscles of respiration may be used, and supraclavicular and intercostal retractions may be seen. Cardiac, pulmonary, and neuromuscular examinations should receive particular attention in patients with dyspnea.

A chest radiograph is frequently helpful in evaluating patients with dyspnea. Characteristic roentgenographic findings occur in patients with congestive heart failure, pneumonia, and pulmonary fibrosis. The chest radiograph may also be abnormal in patients with obstructive pulmonary disease, but the chest film is neither sensitive nor specific for the detection of airflow obstruction; major abnormalities on the chest film are seen only in patients with far advanced obstructive pulmonary disease.

The laboratory is of no use in the detection of dyspnea, but may be of great value in the differential diagnosis and in quantifying the severity of the underlying disorder. Pulmonary function tests are useful in the detection of obstructive and restrictive diseases of the lung and chest wall. The vital capacity and forced expiratory volume in 1 second (FEV1) obtained from simple spirometry usually correlate well with the sensation of dyspnea in most patients with lung disease. More sophisticated and expensive tests are frequently unnecessary. Arterial blood gas studies are generally performed in dyspneic patients, but are of limited usefulness in evaluating dyspnea. There is not a good correlation between the severity of hypoxemia and the severity of dyspnea. Arterial blood gases are therefore, most useful for quantifying the severity of gas exchange abnormalities in patients with established pulmonary dysfunction.

Depending on the findings obtained during the history and physical examination, laboratory testing of cardiac function and neuromuscular function may be useful in making a diagnosis. Occasionally patients require more sophisticated testing, including exercise testing with gas exchange measurements, measurements of pulmonary compliance, and measurements of respiratory muscle strength and respiratory neurologic drive. None of these measurements actually aids in the detection of dyspnea, but may be of some value in explaining or quantifying dyspnea in a patient.

Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition, Walker HK, Hall WD, Hurst JW, editors. Boston: Butterworths; 1990.

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Dyspnea is an uncomfortable abnormal awareness of breathing.

dys / pne / a / is / a / nun / con / fo / rta / bl / ea / b / nor / m / al / a / war / ness / of / brea / thing

repeat syllables randomly,
walking all over the place

alternating:
— medium density
— very dense pronounciation
— whispering

to be repeated n times

Nadia Lichtig, *Blank Spots Score*, 2022

Nadia Lichtig, *Blank Spots (Reichstagbunker) Score*, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers

One might think that the virus is a metaphor for humanity. We have the same instrumental relationship to the earth as a virus. In a way, the human being is the pathogen of the planet.

Philippe Descola, France Culture, February 2020

———

The virus is a metaphor.

spoken robotically,
crossing the canvases barfoot or with socks

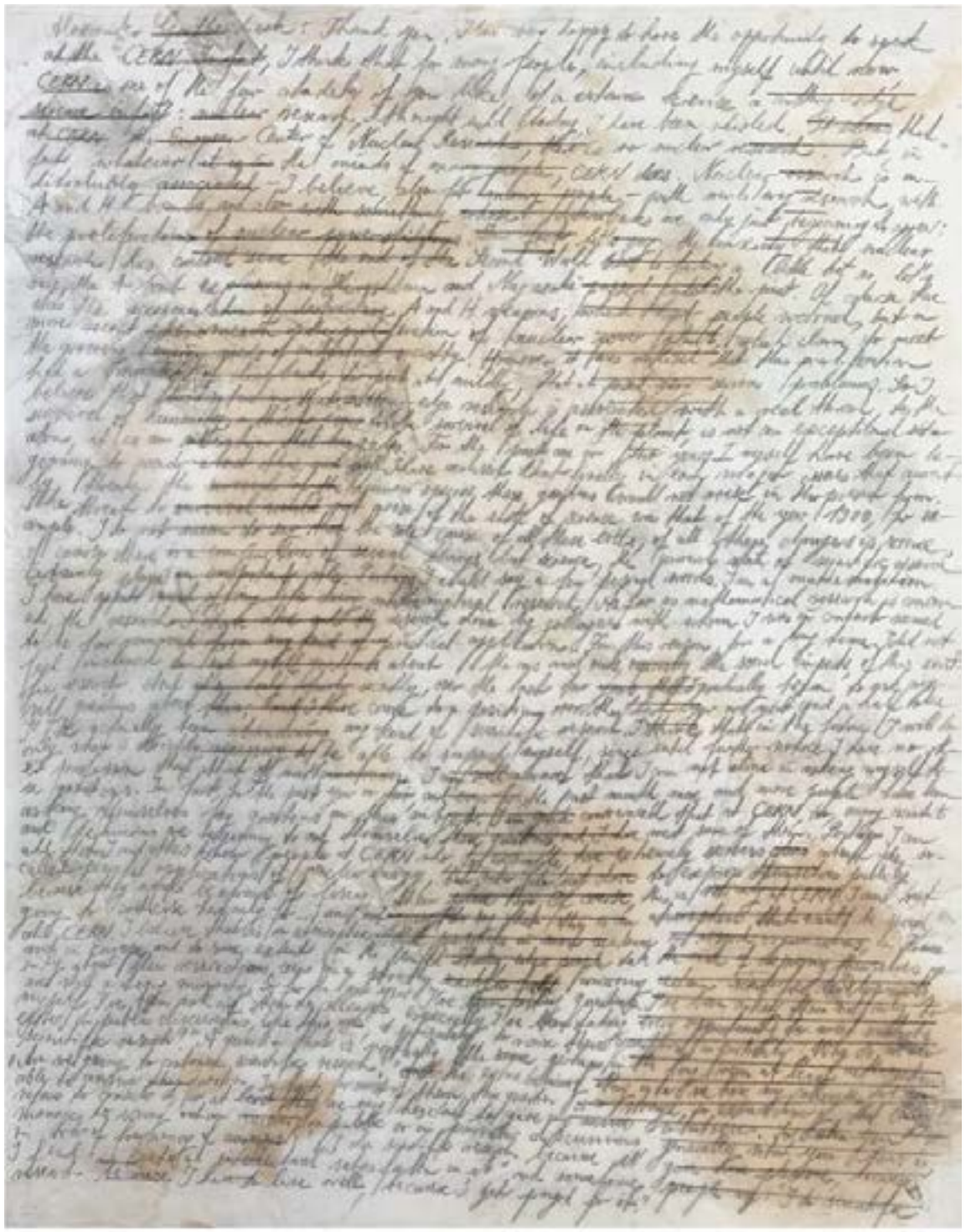
on different pitch levels with glissando up/down:
the / virus / is / a / meta / for / humanity
hum / man /nity

laughter and whistles:
interfering and varying in loudness

Nadia Lichtig, *Blank Spots Score*, 2022

Nadia Lichtig, *Blank Spots* (Reichstagbunker) Score, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers

Nadia Lichtig, *Blank Spots* (Reichstagbunker) Score, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers



Nadia Lichtig, *Blank Spots* (Reichstagbunker) Score, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers

Alexander Grothendieck: Thank you. I am very happy to have the opportunity to speak at CERN. In fact, **I think that** for many people, including myself **until now**, CERN is one of the **few** cita**dels**, if you like, **of a certain** science, a cutting-**edge** science in fact: **nuclear research**, I thought until **today. I have** been misled. **It seems** that at CERN, the **European Centre** for Nuclear Research, **there is no** nuclear research. **But** in fact, whatever **it is in the minds of many people, CERN** does. Nuclear **research** is indissolubly **associated – I believe, also for many people – with mili**tary **research**, with A and H bombs, **and also with something whose drawbacks are only** just beginning to appear: the proliferation o**f nuclear power stations. In** fact, let's **say, the anxiety** that nuclear research has caused **since the end of** the Second World **War is fading a little** bit as, let's say, the A-bomb exp**losions in Hiroshima** and Nagasaki **passed into the past**. Of course there was the **accumulation of destructive A and** H **weapons, which kept people** worried, but a more recent **phenomenon is the proliferation** of **nuclear power plants, which** claim to meet the growing **energy needs of industrial society. However, it was realised that this** proliferation had a number of **drawbacks, to put** it **mildly, that** it pos**ed very serious** problems. So I believe **that this situation, that cutting** edge rese**arch** is associa**ted** with a real threat, to the survival **of humanity, a threat even to the** survival of life on the planet, is not an exceptional situation, **it is** a **situation that has rules.** For the past one or two years I myself have been beginning t**o won**der a**bout this, and well** I have realised that finally in each of the major issues that currently threaten **the survival of the human** species, these questions would not arise in their present form. The threat to **survival would not arise** if the state of science was that of the year 1900, for example. I do not **mean to say that the sole** cause of all these evils, of all these dangers is science, of **course** there is a **conjunction of several** things but science, the current state of scientific research **certainly** plays **an important role.**

Perhaps I could say a few personal words. I am a mathematician. I have spent most **of my life doing mathe**matical-**research**. As far as mathematical research is concerned, the research **I have done and the research** done by the colleagues with whom I was in contact seemed to be far removed **from any kind of pr**actical applicat**ion. For this reason**, for a long time I did not feel inclined to **ask myself questions a**bout the ins and outs, **especially** the social impacts, of this scientific research. And it's **only fairly rec-ent**ly, over the last two years, that I gradually began to ask myself questions about **this, and I've** come to a position over the last **year** or year and a half where I've actually been **abandoning an**y kind of scientific research.

I think **that in** the future I will only do what is strictly necessary to be **able** to **support** myself, since until fur**ther notice** I have no other profession than that of mathem**atician**. I am **well aware** that I am not alone **in asking myself** these kinds of questions. In fact, for the past year or two, and even **for the past month**, more and **more people have been** asking themselves key questions on this subject. **I am quite convinced** that at CERN, too, many scientists and technicians are beginning to ask themselves **these questions, and I have met** some of them. Perhaps I can **add that** I and others know people at CERN **who, for example, have extreme**ly serious **ideas about** the so-**called pea**ceful **applications** of nuclear energy**, but who do not dare** to express **them public**ly, **because** they **would be a**fraid of losing **their place here. Of course, this** is **not the case only at CERN, I am** not going to criticise here only for … I am not **going to say that this is an** atmos**phere that would be special** at CERN I **believe** that it is an atmosphere **that prevails in most academic or research organisations, in France** and in Europe **and** to some extent in the United **States, where people who** take the **risk of expressing themselves o**penly about their reservations, even in a strictly scienti**fic field** concerning **certain scientific developments**, are still a tiny minority.

So for the last year or two I've been asking questions. I've **been asking them not only to myself,** I've been asking them to colleagues, especially for several months, maybe six months, I've been taking every **opportunity to meet scientists** either in public discussions, like this one, or privately, to raise these questions, **in particular: "Why do we do scientific research?** A question that is virtual**ly the** same, **perhaps in the long run at least, as the question:** "Are we going to **continue** scientific research?" And the extraordinary t**hing is to see how my colleagues are un**able to answer this **question. In fact,** for most of them, this question is so **strange, so extraordinary that they even** refuse to consider it, or at **least they** are very hesitant to give any answer what**soever. So when** you manage to wring out an **answer;** in public or private discussions, gen**erally what you hear is,** in order of **frequency** of **answers**: "I do scientific research because it gives **me pleasure, because** I find a **certain intellect**ual satisfaction in it", and sometimes people **say: "I do scientific** research because I have to live well, because I get paid for it."

fabriquedesens.net/Allons-nous-continuer- la-recherche, consulted on 30 January 2021

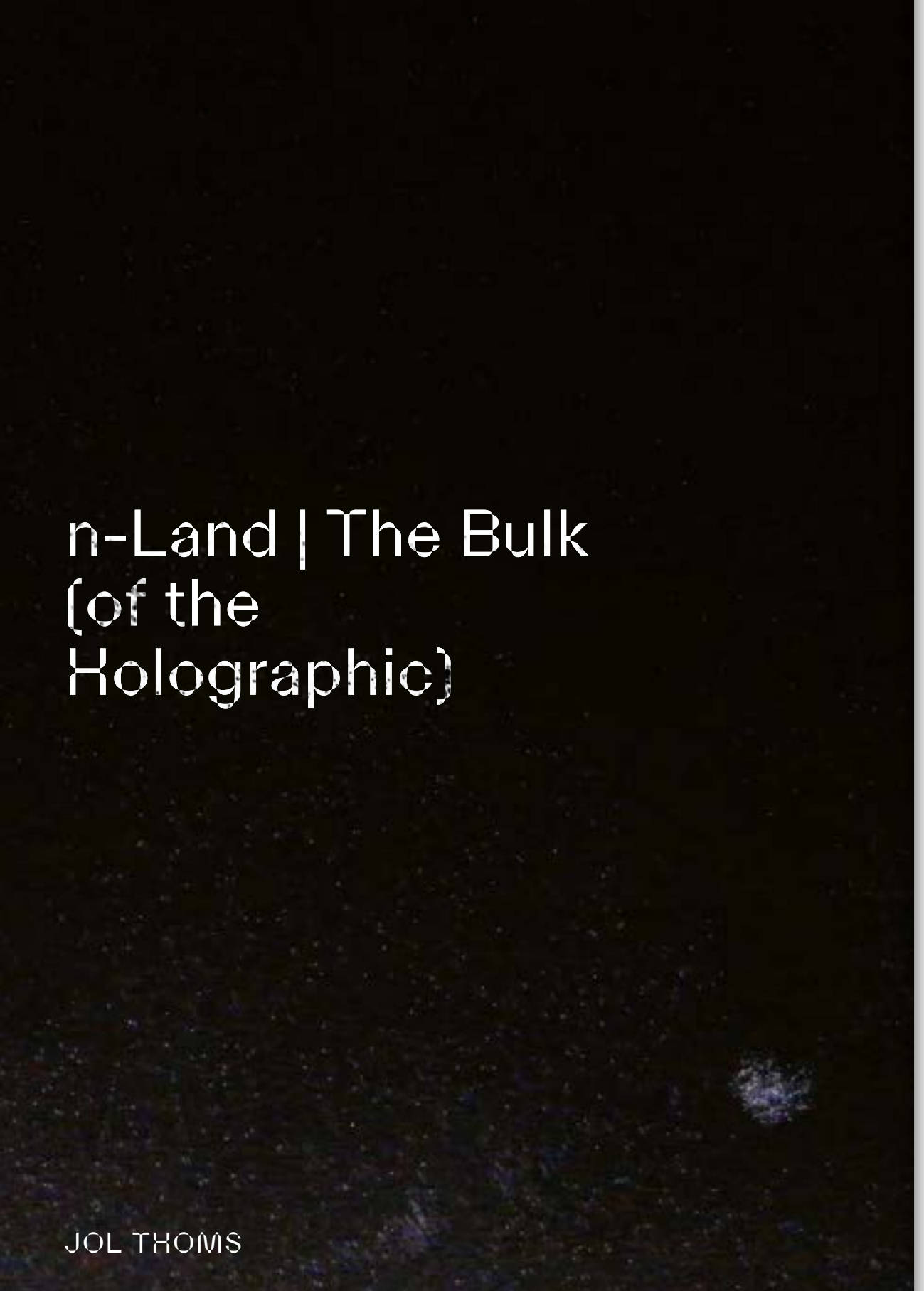
———

Alexander Grothendieck: Thank you.

all words crossed out: mouthed (no sound)
standing at one spot, gazing into the distance

Nadia Lichtig, *Blank Spots Score*, 2022

Nadia Lichtig, *Blank Spots (Reichstagbunker) Score*, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers



Thick sticky odors penetrating bodies.
Unlike hearing experienced:
Listen
Noise densities geopulsing molecular
dusts waving penetrating layers.
Eyes, Lids, Lips, Mouth, Throat, Lungs
Submerged organs exposed.
Through shadows of deep grime
granite towards an all too present
atmospheric pressure in decibels.

The stone walls of the long, kilometers-deep tunnels, the horizontal *drifts* of the mine, are held back by the ubiquitous, haphazard patterning of steel gratings. You can see the jagged rock through the repeating squares of this steel mesh meant to be holding back debris from the two kilometres of granite overhead. There is a forceful wind pouring itself loudly across our minds and bodies, into our various mucous membranes. During initial research for this expedition to SNOLAB, I read that nearly half of the operating budget for the mine is used strictly for air circulation and cooling.[1]

I also read phrases like:
thorium contamination,
geo-neutrino spectrum,
muon-follower cuts,
liquid scintillator with metallic
oxide nanoparticles.

The vast underground network of drifts in the Creighton Mine cut thousands of meters underground, with their vast and brash fan systems pushing the air all around the circuitous piping of the labyrinth, transforms the system into something once only imagined by poets: a planetary-scale organ humming deep in the ranks and stratigraphies of the ancient Precambrian rock of the Canadian Shield. Within this Earth instrument (part mine, part landscape, part laboratory, part air circulation system), standing waves multiply into tremendous forces of vibration and resonance, pulsating my eyes and internal organs, shifting time and space, morphing my frequency toward a quantum composition.[2]

There, two kilometers underground, within the planet's best-preserved terrestrial impact structure, I am resonating with the anachronistic murmurs of this ancient wet planet while others close by search out the invisible translucent *spacetimematter* of the cosmos that holds it all together.

It is important for me to know and think with that dense Precambrian granite that literally shields SNOLAB from the chaotic radiative surface of Earth. SNOLAB renders the two kilometers of rock overhead "technical" in this way, as a "redactor" absorbing the constant bombardment of particles and instrumentalizing the rock for advanced Nobel-Prize-winning experimental physics, for dark matter searches, for seeing through the impenetrable-imperceptible. SNOLAB's technological extensions into and *as* the rock make it difficult to know where SNOLAB's landscape-laboratory begins and ends—it reaches far out into (and becomes) the landscape while receiving silent, uncoded messages from the deepest regions of space.

Neutrinos and theoretical dark matter mass-energy are said to be able to pass through light-years of lead without ever slowing down, which means the cosmos is surfaceless for them, without boundaries. This is what makes these "flavourful" particles so interesting to think and collaborate with.[3] SNOLAB is probing the borderless and translucent energies of measurable nature. In doing so, it must also transcend naive limits, complicating notions of opacity and transparency, becoming landscape, environment, and ecology. The distinction between nature and technology is doubly troubled there. Attending to the imperceptible elements of the laboratory itself, analyzing its tools and processes, is a

1 See "About SNOLAB," SNOLAB, snolab.ca/about/about-snolab.
2 See Pauline Oliveros, *Quantum Listening* (Newcastle: Ignota Books, 2022); and, Pauline Oliveros, *Deep Listening: A Composers Sound Practice* (Lincoln: iUniverse, 2005).
3 Continuing in the tradition of the quantum's othering of what and how we know about nature, neutrinos are known to "oscillate" between three different masses (no other particle does this). These three described masses (what the Nobel Prize was awarded for), are referred to as "flavours" in the physics community. That neutrinos dynamically shift between flavours (masses), again reveals nature's queer capacity to outperform and bypass classical, linear conceptions of it.

counter-methodology that I use as a means to approach and learn about the laboratory, opening it up to its *more-than*. One such tool is the "holographic principle," borrowed from string theory and m-theory, which posits ten and eleven dimensions of space, of which our four-dimensional spacetime is but a shadow.[4] Physicists apply extra dimensions to their equations when trying to understand how particles and forces fit together in a unified theory of physical nature. *Contemporary particle physics is only possible with such higher-dimensional space.* It doesn't work otherwise. Illuminating more dimensions of SNOLAB as a site means considering it on its own terms: as both landscape and laboratory.

As a landscape-laboratory, SNOLAB extends beyond the discipline of physics, out through its eco-techno-cosmo-logical assemblage into other dimensions of society, culture, and environment. Like the neutrino oscillations that the lab collaboratively described to win the Nobel Prize for Physics in 2015, SNOLAB itself changes its flavours depending on one's perspective.[5] Since it renders the vast dense granite of the Canadian Shield as a technology, it necessarily becomes entangled with the polyphony of meanings, issues, concerns, and stories of the Precambrian rock and what the rock supports. To understand the science that goes on there, to understand the lab as a form of poetics, I also have to fold myself into these multiple dimensions and extensions of its otherwise imperceptible being.

In *Drift: Art and Dark Matter*, the installation *n-Land: the holographic (principle)* (2021), with all of its prints, sculptures, sounds, rocks, particles, and moving images, is in this case considered a projection from a seven-dimensional artifact. As the light/void of spacetimemattter passes across that object, it appears to us as an exhibition of distinct objects contained by walls, time, and other media. In reality, that seven-dimensional object is unified and distinct while having neither an inside nor outside, as these sorts of categories are irrelevant in higher-dimensional space.

In string and m-theory, there are ten and eleven dimensions, with seven of them "curled up" microscopically, and quantum theory includes the possibility of infinite dimensions. Scientists at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (known as the McDonald Institute)[6] also use this "holographic principle" to speculatively "print out" all the possible particles and forces of the cosmos (through blackhole evaporation at future particle colliders).[7] My practice, following a holographic principle that makes extra dimensions operative for understanding nature's connections, attends to the interference patterns and diffraction phenomena that are characteristic of any holographic (volume). As particles, landscapes, and disciplines cross, intersect, and interfere with one another they build up higher dimensional structures that cast shadows in our own realm, reconstructing the very notions of reality.

> I read phrases like:
> inorganic crystals,
> matrix element calculations,
> high multiplicity transverse
> momentum signature.

1.85 billion years ago, a 15-kilometer wide comet (with bits of asteroid frozen within it) crashed into (on the land where the settler-named Sudbury is now located), causing a 150- to 200-kilometer-wide crater—a ring

4 For readers interested in learning more about the rudiments of these theories, see Chanda Prescod-Weinstein, *The Disordered Cosmos: A Journey into Dark Matter, Spacetime, and Dreams Deferred* (New York: Bold Type Books, 2021); and, Michio Kaku, *Hyperspace: A Scientific Odyssey through Parallel Universes, Time Warps, and the Tenth Dimension* (New York: Oxford University Press, 1994).

5 See Stephanie Hanel, "The Neutrino Catchers: Takaaki Kajita and Arthur B. McDonald," Lindau Nobel Laureate Meetings, lindau-nobel.org/the-neutrino-catchers-takaaki-kajita-and-arthur-b-mcdonald.

6 See "What is the McDonald Institute," Arthur B. McDonald Canadian Astroparticle Physics Research Institute (website), accessed June 6, 2022, mcdonaldinstitute.ca/about/what-is-the-mcdonald-institute.

7 For fabulative prospects of working with extra dimensions and blackholes for full spectrum and non-thermal particle discovery, see Ningqian Song and Aaron C. Vincent, "Discovery and spectroscopy of dark matter and dark sectors with microscopic black holes at next generation colliders," arXiv open-access archive, arxiv.org/abs/1907.08628.

long deformed over the eons of erosion and tectonic shifts. In the mining and geological maps of the area, the striking oblong shape—known as an *astrobleme*—that was left from that cosmic event now has the appearance of a massive gash or a wound. And it is with/in this crevice that SNOLAB is located—deep within the second-oldest and second-largest terrestrial impact structure known on Earth. The impact from that unnamed comet was so dramatic that the mantle itself fractured and a large bowl of molten material spewed up from within the Earth, forming what billions of years later, in the Holocene and Anthropocene, is mined and removed for artisanal, technical, and economic advantage. The Sudbury Basin produces hundreds of tonnes of copper, nickel, and other metals every year because of this ancient cosmic collision. It has been estimated that since 1901, metals valued at more than 100 billion US dollars have been extracted from that site.[8] The molten material that emerged from deep within the Earth lures so many miners that it has become the largest mining community *in the world*.

> 1.85 billion years ago, in the Paleoproterozoic Era, time itself had an entirely different rhythm. The days are said to have been only 20 hours long, a year lasting 450 days.

The sheer scale of the variation in Earth's terrestrial time signatures triggers a five-dimensional shift in my understanding of the site. I've become indebted to this ancient convergence between comet and planet that allowed me to enter deeply into the Earth's surface. Ancestrally carved out by this primordial meeting, thousands of sculptures (known as "shatter cones" to geologists: concretions formed by the pressures and temperatures of the impact) are also found in a giant ring formation through the surrounding rock. Each of these conical sculptures surrounding the impact site points inwards, towards the centre.

8 This is a conservative estimate. In 2019 alone, more than 10 billion dollars worth of minerals were extracted. "Sudbury is Kind of A Big Deal in Mining," *Northern Ontario Business* (March 28, 2022), northernontariobusiness.com/industry-news/mining/sudbury-is-kind-of-a-big-deal-in-mining-says-industry-report-5202739

> 1.85 billion years ago, that icy comet collided into a primordial supercontinent named Nuna.

Nuna, an ancient landmass, existed eons before Gondwana or Pangaea, the better-known supercontinents in Earth's history. All the continents we know today, separated by water and "national interests," were still connected back then, and life, though only single-celled archaea and microbial mats, was associated in this simple, modest way. While there were no plants, animals, or birds, there was Nuna and a vast ocean. Two kilometers underground, in the dense granite of the mine, just one hundred metres or so outside the entrance to SNOLAB, sounds resonating within the ancient rock invoke this otherworldly time and atmosphere, helping me imagine life, nature, space, and causality very differently; helping me to understand the complexity of the landscape (of time) that the laboratory has become a part of.

The meeting between Nuna and the comet is an essential yet nearly imperceptible part of the story of Canada's rich geology, of SNOLAB and the Creighton Mine—each institution owing a great debt to that unnamed comet that sank into Earth so long ago, opening deep passages through the planet and in turn creating possible "portals to the dark sector"—the invisible, uncharged mass of dark matter.

> I read phrases like:
> superluminal Cherenkov radiation,
> fourteen magnetic compensation coils,
> linear alkyl benzene.

Passing a seven-dimensional light upon SNOLAB, we can read the shadows of its hidden geometries and relations as they project into our less bulky four-dimensional spacetime. Extending SNOLAB's boundaries out into the surrounding landscape, far beyond its creamy undulating beige walls—out into Sudbury Basin—we discover that this landscape-laboratory's territory is also subject to the Robinson-Huron Treaty (RHT), signed 9 September 1850, with

seventeen Anishinaabeg (Ojibwe) leaders.[9] The 170-year-old Treaty was unique at the time for a number of reasons, one of them being a clause committing to increasing annuities payments: annual payments made to the ancestors of the original signatories for the use of the land. The RHT's annuity escalator clause stated that as the value of the land increased over time, the sums to be paid annually to the ancestors of the Treaty signatories would also increase. Today, and for the last several years, the First Nations that signed the RHT are suing the Canadian government for not living up to the nearly two-centuries-old Treaty: since 1874, in the largest mining community on the planet, the annuities have *never* increased.[10]

SNOLAB doesn't only make neutrino oscillations perceptible and measurable, but by becoming landscape, it also makes these seemingly translucent elements visible to me.[11] Since 1874, the value extracted from the land has, of course, increased exponentially, by orders of magnitude many times over. Today, the value of nickel alone in Ontario is estimated in the order of some 4 billion US dollars annually, much of it coming from Sudbury and the RHT territory. Yet, for the last century and a half, the Anishinaabeg (Ojibwe) members have only received *4 dollars per year*.[12] This tremendous discrepancy in what is owed is not entirely dissimilar from the grave discrepancies in our cosmological models and galaxy rotation curves that suggest dark matter and dark energy make up 96 percent of the cosmos. In the coming years, the courts, now in phase three of this important federal case, will decide the reimbursements and future payments—a significant, if not long overdue victory for the Robinson Huron Waawiindamaagewin who represent the sovereign Ojibwe treaty signatories.[13]

> Cosmology is always also cultural, economic, political, environmental, and sensual.
>
> What can or cannot be attended to by settler science matters.

By the 1970s, more than 200,000 acres had become barren owing to generations of sulphur dioxide gas, as well as arsenic, cadmium, copper, lead, nickel, and selenium chemicals from smelter emissions. Since then, comprehensive ecological recovery programs have transformed the landscape back into a living creature using lime, fertilizer, and trees that are more comfortable in these acidic conditions. For this reason, Greater Sudbury is known as one of the largest regreening projects ever undertaken.

The holographic principle in physics that utilizes ten- and eleven-dimensional space for figuring out how nature's forces and energies fit together is also useful for thinking about how these multiple dimensions and perspectives of the landscape-laboratory fit together in a site that is a mine, a 1.8-billion-year-old impact crater, the site of a major federal annuities case, a regreening project, and a dark matter laboratory.

The theoretical reality of spacetime's hyper-dimensionality, which allows me to work with multiple dimensions and geometries of the landscape-laboratory, also signifies nature's holomorphism, i.e., its capacity to be fully present in each and every space, *at every point of its domain*—a truly radical relationality that makes notions of entanglement seem almost quaint. Like Nuna (Earth's ancient terrestrial connectedness), or like the anarchic neutrinos that unsettle a century of physics' best models, in the bulk of the holographic we can see the inner, outer, and other relations that are otherwise obscured by outdated perspectives. These connections gesture beyond dualisms, universalisms, or other pre-quantum mindsets that continue to plague the world, its knowledges, and behaviours. A holographic reformulation of reality and art allows me to perceive worlds of polyphony that celebrate difference, cherish nature, attend to (what) matter(s), and signal beyond arbitrary separation and division.

Back in the "cosmic latté" beige of the laboratory, physicists and engineers work toward proving the existence of the invisible particles that weigh heavily in their models of physical reality. Deep underground, they activate the two kilometres of rock overhead as technical device, as a cosmic radiation redactor, putting the shield in "Precambrian Shield" to good use, rendering nature technological. In the meandering walls of SNOLAB, many layers of invisible or imperceptible phenomena are in operation: from the billion-years-old impact event to the land-use relationship with the eco-technical shield and the Treaty that rendered the land extractable, opening the underground drifts for the lab to exist and win a Nobel Prize. These phenomena allow me to travel deeper into the Earth than I could have ever imagined. There, deep in the rock, I invoke a process learnt from a dream and hum a simple oath into the dense, warm, crystalline granite of norite rock that shapes the echoing wind. Over the days and months, I register a trace of an intangible poem hovering as a higher dimensional memory, a scent that is composed with flavours of the non-linear entanglements of quantum ecologies.

9 See Karl S. Hele, "Robinson Treaties of 1850," The Canadian Encyclopedia, thecanadianencyclopedia.ca/en/article/robinson-treaties-of-1850.

10 See "History," Robinson Huron Treaty Litigation Fund (website), accessed June 6, 2022, robinsonhurontreaty1850.com/history. On the ongoing legal case, see Leyland Cecco, "Ontario says 'colonization' costs mean it does not owe First Nations billions," *Guardian* (3 February 2023), theguardian.com/world/2023/feb/03/ontario-colonization-costs-billions-first-nations-treaty.

11 With "translucent," I am referring to the particular particles engaged by SNOLAB while also invoking the history of settler media landscapes that render Indigenous issues and sovereignty "invisible," flattening deep historical inequity, exploitation, and expropriation into imperceptible dimensions.

12 Member nations are Atikameksheng Anishnawbek, Aundeck-Omni-Kaning, Batchewana First Nation, Dokis, Garden River First Nation, Henvey Inlet First Nation, Magnetawan, M'Chigeeng First Nation, Missisauga, Nipissing First Nation, Sagamok Anishnawbek, Serpent River, Shawanaga First Nation, Sheguiandah, Sheshegwaning, Temagami First Nation, Thessalon, Wahnapitae, Wasauksing First Nation, Whitefish River, Wikwemikong and Zhiibaahaasing First Nation.

13 See "Introducing the Waawiindamaagewin," Treaty of 1850: Robinson Huron Waawiindamaagewin, waawiindamaagewin.com/2021/10/08/introducing-the-waawiindamaagewin.

JOL THOMS is an artist, sound designer, and researcher based in London, United Kingdom, where he is a lecturer in the MA Art & Ecology at Goldsmiths University and a faculty member of Critical Ecologies. His works cross and reconfigure boundaries between the non/human, the ineffable, cosmological, and the scientific using strategies from quantum field theory, environmental humanities, and feminist anti-colonial science studies. He is the founder of the *Radio Amnion* sound art project, commissioning and transmitting artists' compositions of care deep in/to and for the Pacific Ocean on each full moon. Thoms's critical transdisciplinary practice advocates for an expanded understanding and ethical engagement with diverse knowledge practices by attending to radical pluralities of sites, phenomena, and experiences beyond the measurable and quantifiable.

Thoms won the MERU Art*Science Award (2016), was shortlisted for the New Technological Art Award (2019), and was a Fellow of the Akademie Schloss Solitude, Stuttgart (2016–17). He received a practice-based PhD in Creative Media for his *Quantum Ecologies* thesis from the University of Westminster (2021), a *Meister* in Contemporary Fine Art from the Städelschule in Frankfurt, Germany (2013), and an HBA from the University of Toronto (2009). He was a participant in the *Anthropocene Campus 1 & 2* at the Haus der Kulturen der Welt, Berlin (2014/16) while he collaboratively developed and led an experimental eco-arts pedagogy "IAK" with artist-architect Tomás Saraceno at the Technische Universität Braunschweig (2014–16).

Thoms recently participated in: *An Oceanic Hearing*, AmbikaP3, London (2022); *Unknown Unknowns: An Introduction to Mysteries*, 23rd International Triennale Milano (2022); *Vision Creep*, Pleasure Dome, Toronto (2021); *Sonic Continuum*, Nottingham Contemporary (2020); *Who Wants to Live Forever*, Kunsthalle Trondheim (2020); *Rencontres Internationales Paris/Berlin: Contemporary Moving Image* (2019); Istanbul Experimental Film Festival, Kadiköy Sinemasi (2019); *Blind Faith: Between the Cognitive and* the *Visceral in Contemporary Art*, Haus der Kunst, Munich (2018); and, *Open Codes: Living in Digital Worlds*, ZKM, Karlsruhe (2017–18). He has published peer-reviewed journal articles in *The Anthropocene Review* (2018), *Diffractive Reading* (2021), and *Frontiers in Marine Science* (2022).

Material Aesthetics: Note 1 — Tangible Possibility

DENISE FERREIRA DA SILVA

An aesthetic judgment in general can therefore be explicated as that judgment whose predicate can never be cognition (concept of an object) (although it may contain the subjective conditions for a cognition in general). In such a judgment the determining ground is sensation. However, there is only one so-called sensation that can never become a concept of an object, and this is the feeling of pleasure and displeasure. This is merely subjective, whereas all other sensation can be used for cognition. Thus an aesthetic judgment is that whose determining ground lies in a sensation that is immediately connected with the feeling of pleasure and displeasure. In the aesthetic judgment of sense it is that sensation which is immediately produced by the empirical intuition of the object, in the aesthetic judgment of reflection, however, it is that sensation which the harmonious play of the two faculties of cognition in the power of judgment, imagination and understanding, produces in the subject insofar as in the given representation the faculty of the apprehension of the one and the faculty of presentation of the other are reciprocally expeditious, which relation in such a case produces through this mere form a sensation that is the determining ground of a judgment which for that reason is called aesthetic and as subjective purposiveness (without a concept) is combined with the feeling of pleasure.[1]

— Immanuel Kant, *Critique of the Power of Judgment*

Photo: Jol Thoms

1 Immanuel Kant, *Critique of the Power of Judgment*, trans. Paul Guyer and Eric Matthews (Cambridge: Cambridge University Press, 2000), 26.

What framing of the aesthetic becomes possible when it encompasses both the experience of the perceptible and the imperceptible? Would it remain a matter of judgment, as it has become since Kant's formulation? What becomes of experience itself? And sensibility? What happens to sensibility when, in addition to that which reaches the senses, it includes what occurs in the very composition of what happens and exists? In this note, I speculate on the possibility of an approach to what falls under the term "aesthetic," which, instead of accepting current formal assumptions, entertains a proposition for the sensible as corresponding to an existence that gives the haptic and the sonic as much value as is ascribed to the optic under dominant culture.

Many experiments taking place at SNOLAB[2] are devoted to the identification of still theoretical elementary particles called WIMPs (Weakly Interacting Massive Particles),[3] which would explain—as they are the cause for—cosmological observations that can be accounted for by the known visible matter found in the universe. Because whatever causes these events has mass, it is matter; but, given that it does not interact with the electromagnetic spectrum, it has received the qualifier "dark." These cosmic events are actually gravitational effects—primarily regarding the size and spinning of galaxies and the bending of light—which do not seem to result from interactions among observable matter. SNOLAB's experiments are carried out underground (to avoid the interference of solar and other kinds of radiation) and are designed to capture WIMPs by detecting their "effect" on the composition of solid or liquid materials at the atomic level. In the notes that follow, I take one of the experiments being done with solid matter as the point of departure for speculative exercises that characterize a materially grounded aesthetic and consider its implications for thinking and knowing. More specifically, I take the approach to existing things suggested by physicists' and cosmologists' attempts to discover the composition of what amounts to 27 percent of the universe and speculate on a formulation of the aesthetic that is not premised solely on visibility.

A question posed by Sunny Kerr in the curatorial statement accompanying *Drift: Art and Dark Matter*—How to study a "known unknown"?—inspires these brief but errant itinerary of comments, which mirrors Kant's building of his program on early classical physics. I am basically wondering about the kind of thinking and knowing, and the kind of sense-making, that takes the dark matter experiments at SNOLAB as inspiration for a departure from the image of existence that mediates both the prevailing scientific and common sensical approaches to what exists and what happens. I am moved especially by the fact that scientists are attempting to capture something simple (if WIMPs do indeed exist), something that happens all the time, everywhere, to everything that has material existence. As usual, all I want to do here is contemplate what the lab's findings and descriptors offer to the critical task of exposing the limits of—and limitations imposed by—Post-Enlightenment thought, and the radical task of releasing the world from these constraints by opening up possibilities for knowing and existing otherwise.

2 See "About SNOLAB," SNOLAB, snolab.ca/about/about-snolab.
3 See "Active Experiments," SNOLAB, snolab.ca/science/experiments.

1.1 The Known and/in the Unknown

How is it that something that is known to exist because of what it makes happen to the largest cosmic composites (galaxies) is supposedly to become known even better through the observation of what it might make happen to the tiniest composites? Experiments searching for the dark matter particles are carried out in radiation-free labs deep underground or in mountains. SNOLAB experiments, unlike those carried out at CERN (European Council for Nuclear Research),[4] do not involve high-speed collisions at high temperatures that seek to replicate the first moments of the Big Bang. Instead, they are low-temperature, low-energy experiments designed for detecting dark matter interacting with solids and liquids—germanium crystals, liquid argon, CF3I, and capacitors (charge-coupled devices, known as CCDs). Most experiments test the theory that dark matter is composed of yet-to-be-detected particles called WIMPs. All of the experiments carried out at SNOLAB follow the same detection principle: "a WIMP scatters off a nucleus of ordinary matter like a billiard ball, and the recoiling nucleus leaves a tiny energy deposit in the detector."[5] While this description of detection takes the form of Newton's laws of motion—which remain the basis for our descriptions of how solid things affect one another—it differs in that the focus is not on exterior movement (dislocation in space) but on interior movement (alteration in format or content), that is, on the change in the material composition of that which is used to detect the particle: the "tiny energy deposit," which is to be captured as an electrical charge, a phonon, ultraviolet light, or a bubble signal.

It is precisely this departure from our common understanding of interactions involving material things—whether in the solid, liquid, gaseous, or plasma state—that interests me here. In particular, I want to speculate on what becomes thinkable and knowable—and in what ways—if, instead of an image of existence that figures material things in the Newtonian way, that is, by focusing on the exterior events (that is, on interactions) that can be formally (mathematically) described, the focus is placed instead on how the event alters the elemental composition of that which is involved, and as such also of the composition of the context within which the event takes place.[6] Even if this remains imperceptible outside of a lab because it is happening at the elemental level, and even if it occurs in that which does the feeling, these alterations do happen. What if humans also went about their daily existences by attending to similar

4 See "About CERN," CERN, home.cern/about.
5 See "Unveiling the Hidden: The Quest for Dark Matter Particles," DAMIC-M, damic.uchicago.edu/science.php.
6 Certainly, such an alteration of the elemental composition can be formally described; this is what the scientists at SNOLAB are working towards.
7 Kevin Dunegan, "Study: Collateral damage cosmic rays increases cancer risks for Mars astronauts," Phys.org, phys.org/news/2017-06-collateral-cosmic-rays-cancer-mars.html.

(de-/re-)compositions that happen all the time—such as cosmic rays and other sources of radiation.[7] What if our image of the sensible included this elemental level of materiality, where things touch and even decompose or recompose one another, although none of this is felt because it is both invisible and imperceptible?

1.2 The Intangible and Touch

Some things have been taken for granted for such a long time that most of us don't think it's worth asking questions about them. Among such assumptions, visibility is perhaps the most ubiquitous and the least challenged.[8] From the famous saying about a tree falling in the forest, in denunciations of injustice, in the key statements on aesthetics—and present in the very phrase *dark* matter—visibility goes largely unchallenged. Visibility is presupposed by the description of dark matter as something that does not interact with the electromagnetic spectrum. Dark matter is not visible, not at the lowest frequencies (radio waves), nor the highest frequencies (gamma rays). What SNOLAB's dark matter experiments have inspired is a take on sensibility that attends to the abstract while retaining an interest in the figural or compositional, but that also places the haptic and the sonic on the same level as the optic—that is, theirs is an approach to the sensible that does not subject matter to visual criteria, or touch to vision.

The description of the SuperCDMS (Super Cryogenic Dark Matter Search) experiment is perhaps, on closer examination, the least straightforward, while it is apparently the simpler of the seven listed experiments at the time I consulted its webpage.[9] Taking place deep underground, once underway the CDMS detectors will capture "the minute crystal lattice vibrations (phonons) and ionization (charge) generated within the detector crystal by elastic collisions between detector nuclei and low-mass dark matter particles."[10] The "energy deposited in a detector by an interacting dark matter particle," the description explains, "may be as low as a few tens of electron volts (eV)."[11] Basically, this experiment consists in detecting the changes through a shift in the crystal's composition—that is, the generation of a phonon (an excitation) and electron (ionization) by a collision with the very large WIMPs.[12] The detectors are not designed to make the WIMPs visible, but rather to gather details on what happens when they *touch* solid matter. Ranked lower among the lowest players in knowledge

Nadia Lichtig, *Blank Spots (Reichstagbunker) Score*, 2022, drawings and texts based on the frottages, to be interpreted as a choral performance for one or more singers

8 This is the case within dominant culture, that is, outside of critical discourses.

9 See "Active Experiments: Super CDMS," SNOLAB, snolab.ca/experiment/supercdms. For descriptions of all SNOLAB's active and completed experiments see "Experiments," SNOLAB, snolab.ca/science/experiments.

10 "SuperCDMS | Super Cryogenic Dark Matter Search," SLAC National Accelerator Laboratory, supercdms.slac.stanford.edu/overview.

11 "SuperCDMS | Super Cryogenic Dark Matter Search."

12 Since weakly interacting massive particles (WIMPs) are yet to be detected there is no information regarding their size. But, as the name indicates, they are thought to be larger than some elementary particles included in the standard model (tau neutrinos, electrons, photons, etc.). See Chelsea Gohd, "Dark Matter Particles Must Be Smaller Than We Thought," (1 June 2018), space.com/40766-dark-matter-particles-smaller-than-thought.html.

13 "Dark Energy, Dark Matter," NASA Science (website), accessed September 2, 2020, science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy.

(namely, the senses), the haptic is the only mode of perception which makes up something that is everywhere, including in very cold chambers located two kilometres underground, and constitutes between 23 and 27 percent of the known universe.[13] It turns out that if we want to know more about the very stuff that makes up our planet and the cosmos, we need to figure out how to "feel" being touched by it. If, on the other hand, we wish to take as inherent to our existence that which we do not feel, then we require an image of existence that can take into account that which happens but nevertheless cannot be directly apprehended by our corporeal capacities for learning; that is, we need to be satisfied with the possibility that dark matter exists because it is expressed as/in the form of gravitational effects without any assignable cause.

1.3 The Coarsest and the Noblest

What image of existing and knowing would this allow? In order to identify the point of departure, let me recall two aspects of the Kantian program that still inform how we go about knowing and appreciating what happens and what exists. On the one hand, Kant borrows from Newton's classical physics—in particular the centrality of the optic in the very description of the most basic conditions of possibility for knowledge: the formal (pure) intuitions of space and time, which correspond to Newton's absolute space and absolute time. In Kant's framework, space and time play a similar role as they do in Newton's presentation of the laws of motion: space (the image of separation) and time (the image of succession); the former offers the possibility of separating that which changes from its context, while the latter gives a sense of something that remains despite changes. More importantly, the pure intuitions of space and time are the fundamental conditions for scientific knowledge because they are the condition of possibility for sensible experience. For Kant, science is not interested in knowing the "thing-in-itself;" rather, science is only interested in things as phenomenon, that is, as they appear—already apprehended by the senses after being organized (separated and unified) by space and time. That is, without these intuitions that reside in the mind, not in the things in themselves, scientific knowledge that meets the criterion of logical validity could not be possible.[14]

On the other hand, I also have in mind Kant's positioning of aesthetic judgment, or reflective judgment, in terms of an agreement between what exists, the Imagination, and the Understanding; and, more importantly, that the feeling of the beautiful arises from a judgment that finds in the object's form (not

14 Immanuel Kant, *Critique of Pure Reason*, eds. Paul Guyer and Allen W. Wood (Cambridge: Cambridge University Press, 1999).

15 Kant, *Critique of the Power of Judgement*, 48.

16 "The sense of sight," Kant postulates, "even if it is not more indispensable than that of hearing, is still the noblest, because among all the senses, it is furthest removed from the sense of touch, the most limited condition of perception: it not only has the widest sphere of perception in space, but also its organ feels least affected (because otherwise it would not be merely sight). Thus, sight comes nearer to being a *pure intuition* (the immediate representation of the given object, without admixture of noticeable sensation)." See Immanuel Kant, *Anthropology, History, and Education*, eds. Günter Zöller and Robert B. Louden (Cambridge: Cambridge University Press, 2007), 267–68.

its content, substance, or matter) an agreement with the capacities of the Understanding.[15] Consistently, this privileging of the formal (in both the philosophical and mathematical sense) in the very formulation of aesthetic apprehension corresponds to the privileging of vision with regard to knowledge.[16] There is, of course, nothing new in this celebration of the optic as the sense that best resembles abstraction—Plato's allegory of the cave attests to its defining role in western epistemology.

Let us consider how the privileging of the optic is related to the significance of form:

- Scientifically, as in the sense of the logical form (Kant's a priori) but also, in particular, in the notion of the pure intuition of space, which allows for physically separating the things that exist;
- Aesthetically, as form refers to the logical form (the principle of purposiveness of nature is transcendental, that is, a priori) and to physical form, that is, the shape of the object of judgement.

In both cases, the slippage between the formal (pure or a priori) and format (shape) signals what is perhaps a purposive ambiguity, which is more interesting to exploit in terms of Kant's equivalence of sight and the form (pure).

Now, dark matter experiments rely precisely on what for Kant is a lower sense: touch.[17] Again, ambiguity rules but it is not difficult to smooth things out by comparing Kant's descriptions of touch (the "coarsest") and sight (the "noblest") and, of course, his statement that sight is "the furthest removed from the sense of touch."[18] The significance of the optic is given in the very definition of the subject matter of the aesthetic—defined as a kind of judgment—as the beautiful and the sublime. In any event, visual references are so prevalent in Kant's *Critique of the Power of Judgment* that it is unnecessary to rehearse them all again.

1.4 The Cosmic and/in the Quantic

What intrigues me in the experiments being carried out at SNOLAB, and with the SuperCDMS experiment in particular, is the fact that their procedures subject the optic to the haptic and, in so doing, call attention to the multiplicity of the sensible. When observed cosmically, the invisibility of dark matter is compensated for by its effects on large visible existents (the structure of galaxy clusters) and events (the bending of light). This is necessary because dark matter is not observable as a body moving in space and in time, that is, as something with a position, direction, or velocity. Unlike the visible objects of classical physics, dark matter is only observable in what it does to something else, as an existent that alters spacetime. When observed atomically, however, it is hoped that invisible or dark matter could be detected by its effects at the quantic level. SuperCDMS, for instance, assumes that dark matter particles

17 "This sense [of touch]," Kant postulates, "is also the only one of *immediate* external perception; and for this very reason it is also the most important and most reliably instructive, but nevertheless it is the coarsest, because the matter whose surface is to inform us about the shape of the object through touching must be solid." See Kant, *Anthropology, History, and Education*, 266.

18 Kant, *Anthropology, History, and Education*, 267.

Artist Nadia Lichtig photographing the drift entrance to SNOLAB. Photo: Zac Kenny

will cause a vibration of the crystal lattice (manifested in the release of a phonon, a quasiparticle) and the displacing of an electron (ionization); both of which are tangible, haptic events—that is, alterations in the composition of the detector felt as vibration (sound or heat) or electricity.

Both manifestations of dark matter, the cosmic and the quantic, depart from thinking in the Kantian terms that also tend to organize our common sense. Let me return to the abstract character of the visible, which renders it, according to Kant, the most important and superior sense.[19] The connection between visuality and the possibility of a pure level of cognition is more explicit in his description of the power of judgment, which is the effective moment in cognition (logic) and appreciation (aesthetic)—and is given Kant's a priori (pure or formal) condition for judgment: the principle of the purposiveness and the law of specification of nature, which are combined to establish the fact that there is an order in nature that can be uncovered by the Understanding.[20] It is precisely this claim that subjects the aesthetic to logic by occupying what exists and what happens with an order based on differentiation—that is, one that is captured by the laws of logic (the principle of identity, the law of non-contradiction, the principle of excluded middle)—and also accounts for the interiorizing of sensibility. In short, Kant links the aesthetic to a mental feeling of pleasure, which comes from the realization that there is an order in nature that is adequate to human cognition.

What I would like to propose is a speculative exercise that departs the subjective and strays out of Kantian bounds in two moves. First, while retaining the abstract character that sensibility acquires in his description of the aesthetic experience, in this exercise, we could replace the optic with the haptic. Second, instead of naming it "an experience," we could call it what it is: a mental presentation (an image) of what exists and what happens, which, in addition to considering the visible aspects of whatever is contemplated, also considers that which does not pertain to the domain of vision (of form). We could apprehend the aesthetic with regard to its content, substance, matter, or anything which, insofar as the human body is able to apprehend it, would be sensed as haptic and sonic—that is, anything that is manifest as or through vibration. This possibility is already suggested by the SuperCDMS experiment, which seeks to detect matter by setting up a contact that takes place at the quantic level, that is, by observing what happens to the crystal lattice when it is touched by the dark matter particles. Heat and sound would be central to this "material aesthetics," a name I propose in direct contrast to Kant's formal aesthetics.

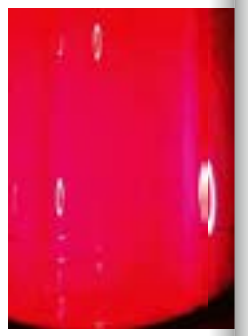
Now such a formulation would be at once speculative and figurative, but probably not contemplative. It would necessarily consider the invisible as ungraspable not due to an extrinsic cause (the cosmic), but because of an intrinsic one (the quantic). As such, it's about what is physically perceptible, that is, *sensible*. Like anything perceptible

19 As discussed above, this is obviously connected with Kant's rendering of formality in *Critique of Pure Reason*; not so much in terms of the laws of logic, though there is a straight line (so to speak) that goes from geometrical shapes to their translation into numbers, equations, and his notion of pure reason.

20 Kant, *Critique of the Power of Judgement*, 48.

through the senses, the im/possibility of knowing this unknown (there is no reason, in fact, to believe that it is a particle) that constitutes what is called dark matter requires contact, connection, and the disturbing of a composite. For this reason, it must remain a speculative exercise. As I said, I do not intend a program built from SNOLAB's findings. I am interested in the *how* of the investigation and in what becomes thinkable when scientific procedures need to adapt to something that goes against its—and our—common sense. In short, the speculative exercise I propose takes what is said to belong in the sensible to the arena of the possible (but not necessarily actualizable) and from there into the realms of the imaginable and the thinkable.

The experiments at SNOLAB postulate a material existent that does not present as something extended (such as a body), nor as something directly observable (objects moving in space and time, interacting with light), which is a counterintuitive proposition. What can be sensed is actual. This is not the case, however, with dark matter, as it violates common sense in two ways: first, it is sensible, even if indirectly, through its gravitational effects, bending of light, etc.; and second, because it does not interact with light at any frequency and does not take any of the shapes of matter (solid, liquid, gas, plasma), it is not sensible in the classical sense at all. In so far as it is anything, it is an "effect" without a known "cause"; it is this "cause" that lab experiments seek, but only as a possibility (it could be that the effect is not caused by matter, dark or otherwise). The SuperCDMS experiment's setup assumes the possible particle will become actual if its contact with known matter is captured; that is, not through direct observation of it, but of the de/composition of the known matter (the detector). Again, it is a cause graspable only in its effect. It is just this speculative aspect of the sensitive that I believe allows us to take dark matter from the sensible to the arena of the imaginable without passing through the actual. Fantasy and artworks, for instance, may refer to sensations and tease the imagination without prior or actual experimentation. There is no reason to deny that WIMPs, insofar as they are theoretical (mathematical) constructs, could also be treated as fantastic creatures or artistic objects, or both. What neither exhibit (in contrast to dark matter) are the indirect sensible effects that lead to speculations about existence. Dark matter is neither fantastic nor artistic—it is not a mental creation—but is instead a cipher for the unknown cause of effects that admit no other explanation (thus far). As such, dark matter exists as a tangible possibility in the realm of speculation—*this tangibility*, which is embodied in the detection methods *offers the event*, *the sensing (not the idea) of Dark Matter, to the Imagination* without the (onto-epistemological) imposition that it (and the events indicating its existence) be graspable by the tools of the Understanding.



Jol Thoms, *n-Land* (still), 2021, video, 5.1 sound, 17 mins.

Photo: Jol Thoms

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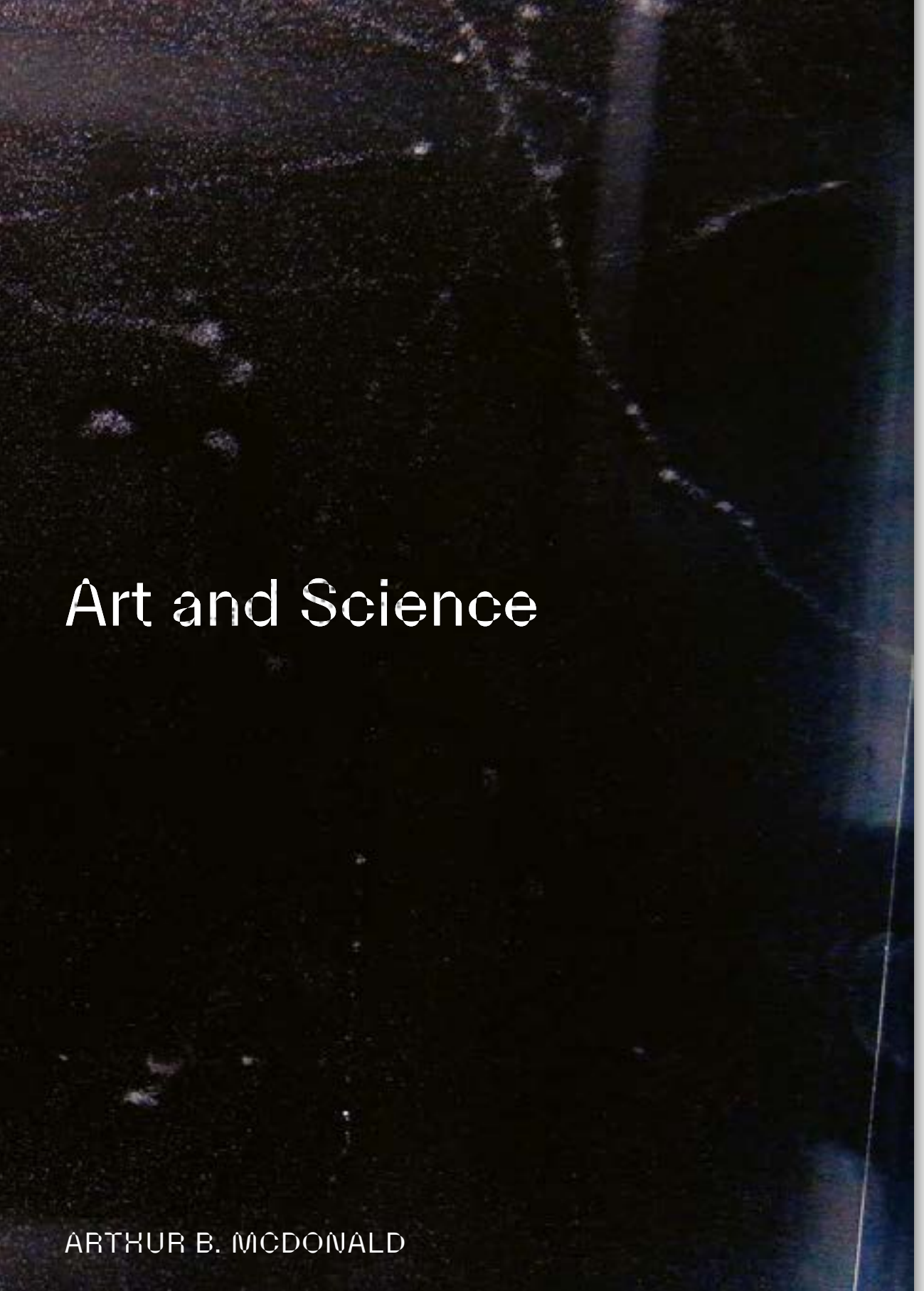


Art and Science

ARTHUR B. MCDONALD

While thinking about *Drift*, an exhibition that presents artists' views of particle astrophysics, I am reminded of a wonderful talk given by Edna Manitowabi, an Indigenous Elder and Professor Emeritus at Trent University's Chanie Wenjack School for Indigenous Studies, for the opening of a conference in Sudbury, Ontario in 2017. The International Conference on Topics in Astroparticle and Underground Physics is a major biannual event for scientists doing research in areas covered by the Arthur B. McDonald Canadian Astroparticle Physics Research Institute (McDonald Institute).[1] Manitowabi spoke eloquently about the Anishinaabe view of the Universe. She spoke of the narratives that are Anishinaabe ways of preserving their relationships with nature, as well as their mythological and religious traditions. They maintain very close relationships with the Earth, the Heavens, the Sun, and Moon, and they are very conscious of how human activities are affecting the world and its manifold relations. One of Manitowabi's key messages was that although we may think that our scientific studies are unique in providing a view of how our world works, there are other ways of acquiring knowledge, such as those of Indigenous people. Despite having similar objectives, they approach things very differently. I expected her message to be a wonderful eye-opener for the scientists in the audience, but when I inquired with them after her talk, some said, "I don't get it." However, others suggested: "That was very interesting. It inspires me to look at our scientific work in a new way." This contrast—between the first reaction, which is characteristic of scientists who approach the world in an objective or reductionist way, and the second, which recognizes the value of a more personal and subjective approach—is worth exploring a bit further.

Clearly, there are many ways to look at the world and many paths by which we try to understand it in greater detail. The particle astrophysicists at the McDonald Institute study the entire Universe, including its evolution, and try to understand it as being created from the most fundamental particles interacting through the laws of physics. We assume that the particles and the laws have not changed since the beginning of this Universe and, so far, we have not found any evidence of change. Mathematics, theory, calculations, and experiments are the essence of our work and most of the time we become wedded to a conceptual framework while trying to find inconsistencies or improvements to this very framework. We favour symmetry in our approach to nature and we often find it in laws that are mathematically complex yet often very simple (and symmetrical) once we have found the underlying principles.

In the wonderful talk by Manitowabi, I was reminded that there are also very different ways of looking at the world and the Universe. These perspectives may be much more interesting, compelling, or accessible to people who do not have years of specialized training in mathematics or physics that are common for our scientists. These other ways of approaching the world provide different perspectives that are worth considering because they reveal aspects, features, and patterns that mathematicians

1 See "What is the McDonald Institute," Arthur B. McDonald Canadian Astroparticle Physics Research Institute website, mcdonaldinstitute.ca/about/what-is-the-mcdonald-institute.

and physicists easily overlook. A clear example of this is the deep concern expressed by Indigenous communities regarding climate change, as well as other threats to the environment, including biodiversity loss and pollution; the recognition of these relations, and the insistence on non-reductive forms of kinship with living beings, is a perspective informed by close contact with the natural world.

As scientists, we must remember that the conceptual framework we use to describe the composition of our Universe could be said to be totally imaginary. No one has seen a quark or a neutrino and, in fact, quantum theory says that we are very limited in our ability to localize or quantify nature at its smallest size due to the limitations of the uncertainty principle of quantum mechanics.[2] This framework can be illustrated, and even "photographed," at scales larger than individual particles by microscopes of varying resolution, but ultimately, the theoretical framework guiding particle astrophysics research is a mathematical construct used to intellectualize our microscopic world. We use this framework to analyze how particles behave with remarkable accuracy; we even piece together how particles were created from pure energy in the original Big Bang and evolved to make up the Universe as we know it.

We then use the framework, including the laws of physics, to design experiments to probe our Universe further. However, we should not be surprised if what we are doing is not fully understood by those who are not familiar with the scientific and mathematical approaches we use. Artists, on the other hand, exhibit the beauty, ambiguity, and complexity of the world in ways that are much more accessible to a wider audience, which includes astroparticle physicists if we can step out of our highly structured mindsets to approach the world in new ways. Artworks that describe our world literally, figuratively, or abstractly can be inspirational, thought-provoking, and educational.

Scientists studying the fundamental basis of our Universe have an interesting approach to their work; they are constantly trying to find anything that does not fit within the accepted theoretical framework or anything that reaches beyond what has been "proven" so far. They have high standards of "proof" and rely on objective peer review processes for validation of the correctness of their work. Scientists are also very open when it comes to sharing the results of their research because they want the rest of society to benefit from their insights, be inspired by them, and build on them. Sir Isaac Newton is known to have said, "I can see farther because I stand on the shoulders of Giants." Science has built its theoretical frameworks through this remarkable and open process of development.

There are many parallels in the arts. Of course, visual art, music, dance, and theatre—in their innumerable forms of expression—have long inspired humans. As with science, openness, communication, and peer engagement have been hallmarks of the artistic world, and like science, the giants of the past are revered for their contributions. The sketches by

Artist Jol Thoms records SNOLAB staff working inside CUTE (a Cryogenic Underground Test Facility) at SNOLAB. Photo: Gerry Kingsley

Jol Thoms, *Robinson-Huron Treaty: Library and Archives Canada, RG10, Volume: 1844/IT148, Microfilm reel: T-9938*, 2020, digital pigment print on paper

the renowned masters of art that were used to conceive and develop their finished works are very similar to the scientist's approach to prototyping in anticipation of large-scale projects. We can learn from each other and benefit from unfamiliar registers of inspiration.

In 1974, Robert M. Pirsig put forward an interesting thesis in *Zen and the Art of Motorcycle Maintenance*, which has since become the best-selling philosophy book of all time.[3] He discussed "The Metaphysics of Quality" and concluded that "Quality" could be the unifying factor between artistic and scientific realms. In an oversimplified summary of Pirsig's more complex discussion, we can say that true Quality can be recognized in a work of art or a finely tuned motorcycle, even by those from other realms who would not be capable of creating an object of such Quality themselves. He says that the recognition of true Quality can be the unifying factor between these otherwise very separate realms or specializations.

Indeed, the works presented in *Drift: Art and Dark Matter* bring the realms of art and science together in just the way that Pirsig imagines, leading to renewed creativity in both domains while also supporting the fundamental work occurring in both realms. And yet, whether you are an artist or a scientist, dark matter remains a difficult concept to grasp. It is literally "what is not there." Or, perhaps a better way to put it is this: "dark matter is what cannot be seen directly" (in contrast, for example, to the stars and galaxies populating the night sky). To date, the most concrete way to infer that dark matter exists is by focusing on its influence on other stars and galaxies through gravity (another of those invisible constructs making up the framework of basic science, along with several other forces of nature).

The idea that there are small particles passing steadily through each of our living bodies—particles that don't stop in our bodies during our lifetime—shows how different the astroparticle physicist's view of our world is. No one will ever see or feel a dark matter particle, but scientists are quite convinced that such particles are one way to explain their large-scale influence, as seen clearly through telescopes. Dark matter may also allow scientists to add another very basic particle to the invisible framework upon which science stands. Because no one has yet observed such particles producing observable physical effects, even with the massive detectors in our world-class deep underground laboratory, SNOLAB (Sudbury Neutrino Observatory LABoratory),[4] there continues to be much creativity and effort in theoretical physics directed toward proposing new types of particles that could be dark matter. At the same time, experimental scientists are developing ever larger and more complex detectors to find more direct indications of the nature of dark matter.

Creativity is clearly a characteristic of both art and science, and inspiration is needed in both areas. Leonardo Da Vinci and Albert Einstein both needed inspiration. Da Vinci is still remembered as a scientist, artist, and architect who was extremely creative in all

2 See Jan Hilgevoord, "The Uncertainty Principle," Stanford Encyclopedia of Philosophy website, plato.stanford.edu/entries/qt-uncertainty.

3 Robert M. Pirsig, *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* (New York: William Morrow and Company, 1974).

4 See "About SNOLAB," SNOLAB website, snolab.ca/about/about-snolab.

areas. Einstein put forward what are now referred to as "disruptive" ideas that fundamentally changed how scientists regard space and time. His theory of general relativity was very important for large distances, while his original ideas for the theory of quantum mechanics revolutionized our concepts of the microscopic world. Einstein had to abandon the accepted theories in the field of physics and adopt entirely new ideas to advance our understanding. In this way, he is like an avant-garde painter purposely trying to disrupt our views of the world through techniques of representation. And, just as the Impressionists helped us to see new aspects of our surroundings beyond direct representation, sometimes we need to challenge the status quo if we want progress.

The technological progress of the twentieth century can be attributed to the breakthroughs of Einstein's work, as *Time* magazine did when they named him The Person of the Twentieth Century in 1999. Einstein did not invent the computer, laser, GPS, or any other technology that has changed our lives; however, it can be argued that none of those technologies could have developed without his "disruption." Interestingly, the way that the scientific establishment welcomed the radical ideas of this obscure patent clerk shows how scientists should remain open to transformative ideas that really challenge our established views of the world. Of course, Einstein faced challenges and pushback at first, just as there were obstacles for the Impressionist painters. However, today Einstein, like Monet, is recognized for explaining new and valuable ways to approach our world and Universe.

How can artists today approach the notion of a dark substance, unseen but influencing the Universe in substantial ways? There appears to be about five times more mass of dark matter than there is in the ordinary matter (protons, neutrons, and electrons). Together, they hold our galaxy (the Milky Way) in its present spiral form. How can a world containing, even depending on, invisible dark matter be represented aesthetically? Are constructs beyond the scientific and mathematical better pathways toward understanding dark matter's place in our world? Often, an individual's appreciation of a work of art arises more from an indirect or unseen feature of the work as opposed to something directly observed.

The artists' responses to the mysteries of dark matter have brought inspiration not only to the exhibition audiences, but also to scientists seeking answers to the very difficult question of how to best describe dark matter within a mathematical framework based on the laws of physics. In conclusion, I would like to note that one element of artistic composition that especially motivates artists is symmetry. Interestingly, this is also a highly motivating principle for scientists seeking theoretical frameworks to describe our world in terms of fundamental particles and laws of physics. Physicists look for a simple, often symmetrical, framework and usually are not satisfied by a theory that is too complicated in its basic principles. Remarkably, at a fundamental level, the laws of nature largely follow

Anne Riley, *dark matter garden*, 2021–ongoing, organic mushroom compost and dirt

Josèfa Ntjam, *Organic Nebula* (detail), 2019, carpet, photomontage

mathematical theorems based on symmetry, and yet many of the breakthroughs arise from the observation of small deviations from these symmetries. Certainly, artists and physicists approach their subjects in very different ways, yet there are underlying principles that motivate them both. As the particle theorist and well-known author Brian Greene has noted, even scientists seeking a fully objective description of the Universe must approach their subject in their own subjective ways.[5] As with the artists and works presented in *Drift*, scientists are inspired by the concept of symmetry, as well as deviations from it—even when the deviations remain unseen.

5 Brian Greene, *The Elegant Universe: Superstrings, Hidden Dimensions, and the Quest for the Ultimate Theory* (New York: W. W. Norton, 1999).

ART MCDONALD is a native of Sydney, Nova Scotia, Canada. He has degrees in Physics from Dalhousie University (BSc, MSc) and Caltech (PhD) and fifteen honorary degrees. Following his doctorate, he worked as a Research Officer at AECL Chalk River Laboratories from 1969–1982, then went on to be a Professor at Princeton University from 1982–1989. McDonald accepted a position at Queen's University in 1989 where he worked as a Professor until 2013 when he became Professor Emeritus. During this tenure, he held a University Research Chair (2002–2006) and the Gordon and Patricia Gray Chair in Particle Astrophysics (2006–2013). He was Director of the SNO Institute from 1991–2003 and again from 2006–2009, and Associate Director of the SNOLAB Institute from 2009–2013. Since 1989, he has been Director of the Sudbury Neutrino Observatory (SNO) Scientific Collaboration.

Among the many awards McDonald has received, he is a Companion of the Order of Canada, and a co-recipient of the 2015 Nobel Prize in Physics with Dr. Takaaki Kajita of the Super-Kamiokande experiment. In addition, with the SNO Collaboration, he received the 2006 John C. Polanyi Prize and the 2016 Breakthrough Prize in Fundamental Physics. He continues to be active in basic research in neutrinos and dark matter.

Grasping the thing requires certain sacrifices. The more precisely one determines a particle's location, the less precisely one can determine its speed. This is where my lesson begins. I want to participate in velocity. I have no patience for trendy discourse that only ever holds me back, fixes things. I don't care about grasping anything. I want to move like all those other cosmic things that can't be detected. To manoeuvre undetectably and to become known only because I can't be controlled: to be felt. I like messiness and mad ways of making things happen—without a plan, or a discourse or a sketch. As an artist I hated printmaking, for instance. I would throw my etching plates out the window, hoping the wind might make something more interesting out of them as a practice than the studio would make of me as an artist. I like the processual nature of sociality and the uncontrollable emotional forces that arise from having woken up after sleeping on a folded ear. I relish in the reverberations of secret pain. I am down with the uncertainty principle in quantum mechanics because I have no idea what I am doing most of the time. I can relate to its vibes. I like to think that folded ears, slept on for years, can be a science that accounts for why I am attracted to institutions. Or, at least why I can wake up every day disturbed by still unknowing why.

EMELIE CHHANGUR is Director and Curator of Agnes Etherington Art Centre, Kingston, Ontario.

At Carleton University Art Gallery, we were privileged to work with Emily Cook, formerly of Critical Distance Centre for Curators, who invited us to partner on a Canada Council for the Arts Sector Innovation and Development grant that funded creative approaches to access in gallery spaces. Inspired by Sunny Kerr's beautiful description of the artworks featured in *Drift* as sensory agents, and given the compelling question at the centre of the exhibition—how do we detect something that cannot be seen?—we decided to focus on a project that moved beyond the limits of the visual in visual art.

Collaborating over a five-month period with eight local individuals who are blind or have low vision, consultant Carla Ayukawa and CUAG educator Fiona Wright designed an audio description tour of *Drift*, creating imaginative, multi-sensory descriptions of and reflections on specific works. Responding to their collaborators' stated desire to navigate the gallery autonomously, they produced the tour as a podcast that could be accessed on a mobile phone and installed a walking route through the exhibition using tactile floor markers.

The audio description tour created and embodied new knowledge—a site-specific script featuring unique interpretations, voices, ideas and even a performance of Nadia Lichtig's score for "To Be Entangled"—while facilitating multifarious encounters with *Drift*. In the end, it became a sensory agent in its own right, charting the contours of auditory experiences of contemporary art.

Artists Nadia Lichtig, Josèfa Ntjam, and Jol Thoms suit up for their journey through the mine to SNOLAB's underground facility. Photo: Zac Kenny

Josefa Ntjam, installation view of *Myceaqua Vitae,* 2020, video with sound, 7 mins. and *Organic Nebula*, 2019, carpet, photomontage. Photo: Toni Hafkenscheid

Photo: Jol Thoms

SANDRA DYCK is Director of Carleton University Art Gallery in Ottawa, Ontario.

The Universe + art = the Universe. This is a thematic adaptation of artist Martin Creed's neon lit gallery banner "The whole world + the work = the whole world." It is a whimsical statement on the simultaneous inexorability and arguable inconsequentiality of art. The "world" would still be here without art, but it would not be the same world. Can the same be said about science? Scientific knowledge? Innovation? The *Drift* project explores notions of what it means to know, to make meaning, and to search for new information.

As the Communications Officer of the McDonald Institute, I work closely with my colleague Dr. Mark Richardson, the Education and Outreach Officer, to host accomplished physicists for public events, and to report on the status of the research in Canada. There is also ample programming for students and early career scientists to develop professional skills that will be useful in their journey. The approach is informative: focus on the relevant data. *Drift* is presented to the public and the astroparticle physics research community alike as a way to view the science through alternative perspectives. The artworks, and indeed, the discourse presented in this publication contain a multitude of thought experiments, theories, questions, and considerations about dark matter, knowledge, and what it means to do science.

The next generation of experiments being designed for facilities like SNOLAB are long-term projects with operation and data collection expected to last a decade or longer. For this long-term research, we can't escape the idea that the process of doing science might contribute as much to its meaningfulness as the anticipated moment of discovery. A career in physics is far more dominated by tinkering and problem solving than making big discoveries. The creative process of art parallels that of science, beginning with a curiosity and deep engagement of the field, and asking questions that necessitate further exploration. Scientists imagine, develop and adapt ways to investigate a question, until experiments can be built, and can perform. An exhibition about dark matter science makes it clear to me that artwork functions in a similar way as a scientific experiment. It is produced by and for the artist, and has an external purpose to interact with an observer and have some kind of effect. The effect of art, like the effect of research, can set out to answer one question, but through the process, asks, answers, and asks again other, less anticipated and tangential questions. In the end, the knowledge gained through the process is incorporated into the broader field, and available for others to build on and ask further questions of.

Multi-decade physics projects are dependent on a framework: continued government funding, dedicated support of the Universities, and the stability of a robust scientific ecosystem. Building and maintaining a network of community-centred researchers is where the McDonald Institute plays an important role. Young students today will soon be leading the research and we work to ensure that they are not only technically

capable, but creatively adept, emotionally resilient, and able to work as part of a team across a range of roles. Including diverse perspectives, like those presented through the *Drift* project, enables critical thinking and demonstrates an openness to alternative ways of learning, knowing, and understanding the human meaning of doing science.

Embracing the unknown might not seem like it would be a foreign concept to frontier scientists, but it may be. Much of the research is bound by contemporary understandings, and scientists are in the routine of using ground-breaking experiments to eliminate ranges of possible dark matter properties. The research is an exploration of a parameter space, and each successive experiment promises to conclude a specific range of possibilities. It is a coordinated and calculated search where there are no failures, only a narrowing of possibilities. *Drift* invites the scientific community, and specifically the astroparticle physics research community to think outside their parameter space. And while yes, there are other theories about what dark matter could be, what we invite with *Drift* is not to explain but to explore. The desire to know and to define is the realm of science. The drive to dissent and wonder is that of art. Art attempts to subvert the definite, offer ambiguity to theory and present open-ended questions that require a different kind of attention and provide a different kind of value. *Drift: Art and Dark Matter* is wonderfully so much more than I could have envisioned. As exhibit curator Sunny Kerr points out in his introductory essay, the artists necessarily "looked past dark matter" as a direct subject, and explored the many aspects of dark matter research that they could sense: the laboratory, the experiments, and the institutional structures that enable their operation. This engagement was more meaningful to the artists and provides a more unique and rewarding experience for viewers.

Scientific Director of the McDonald Institute, Tony Noble, was eager to hear of any progress the artists were making through their pandemic extended studio time. "The artworks from the *Drift* residency went far beyond what I might have imagined a dark matter inspired exhibition might look like, but of course that's the point of such an engagement," says Noble. "The happy surprise was how this focused so much attention on the ways we observe what we think is a fundamental element of nature, but which is only intellectually tangible." He continues, "This experience underlined that curiosity-driven fundamental research is very meaningful as a basic human experience of trying to understand the workings of our universe. I'm grateful for the diverse and emotionally engaging ways the artists reflected on what our particular research means to them, both within and beyond the confines of the lab."

Noble was one of a dozen scientists to take the *Drift* residency's guided deep dive into such material, facilitated by transdisciplinary art and science researcher Elvira Hufschmid. "The workshop gave us both the time and tools to go deeper into the meanings of the artwork and

SNOLAB's underground research facility including CUTE (a Cryogenic Underground Test Facility) at SNOLAB. Photo: Gerry Kingsley

reflect on how aspects of the art referred to the ways we do and don't do science. In taking a closer look at the sculpted feet of Josefa Ntjam's *Luciferin Drop*, it occurred to me that scientist's preference for simple, elegant solutions could be lacking a necessary complexity found by things in nature, which has made me reflect on how I interpret the possible manifestations of dark matter in the cosmos."

Through its transdisciplinary reach, the art encounters of *Drift* provide a model for thinking, for imagination. *Drift* provides alternative narratives about dark matter science and the practices of science. One can imagine, as modelled through Anne Riley's work, what practicing self-care within one's own work might look like. Maybe dark matter is like the subconscious of the Universe, in deep meditation, hugging itself in perpetual self-love. This publication makes the depths to which each artist has taken their processes expansively more apparent. Even as a host of, and in many ways a participant in, the *Drift* project—even having spoken with the artists through their processes, and having seen the artworks in person, the texts presented in this book open countless avenues of thinking-learning.

Dr. Cindy Lin introduces members of the *Drift: Art and Dark Matter* team to liquid scintillator detectors

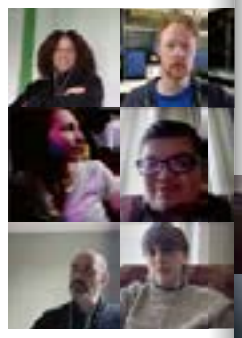
ZACHARY KENNY is the Communications Officer at the Arthur B. McDonald Canadian Astroparticle Physics Research Institute, a seasoned science communicator, and an independent artist. He is one of the co-organizers of *Drift*, and facilitated the partner collaboration and artist residency.

At the Morris and Helen Belkin Art Gallery, we aligned the *Drift* exhibition with academic and public programming. This complement took several forms, the first of which was a performance-conversation between artists Jol Thoms and Denise Ferreira da Silva on the intersections between their works (Jol Thoms, *n-Land,* 2021 and Denise Ferreira da Silva and Arjuna Neuman, *Soot Breath // Corpus Infinitum*, 2020) that played on the Belkin's outdoor screen. The Belkin acquired *Soot Breath // Corpus Infinitum* and further worked with Ferreira da Silva and Neuman on a subsequent exhibition in fall 2022.

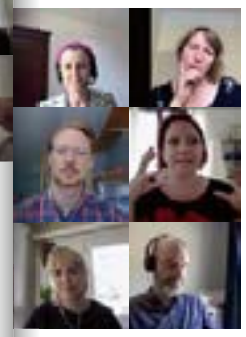
The second is in the form of an interdisciplinary and ongoing research project fusing the praxes of art and science. *Ars Scientia* is a collaboration between the Belkin, the Stewart Blusson Quantum Matter Institute and the Department of Physics and Astronomy at the University of British Columbia. Partnering artists and scientists, the residencies explore the potential for academic art-science collaborations with open-ended outcomes. Each year, the residencies culminate in a research symposium where collaborative findings are shared.

The third was a musical response to *Drift*. Students from UBC School of Music presented a concert at the close of the exhibition that responded to its themes.

And fourth, Anne Riley presented *a gathering for mattering* with Audrey Siegl and T'uy't'tanat-Cease Wyss to share their practices of collectivity and care while watching the sunset in fall 2022. A continuation of Wyss's and Riley's sunset work, as well as Riley's work in *Drift*, this project asks questions about extractive practices and institutional frameworks.



Web-call with guest speaker Sebastian DeLine joined by Michelle Bunton, Josèfa Ntjam, Sunny Kerr, Nadia Lichtig, and Zac Kenny
Photo: Zoom



Web-call with guest speaker Renée Hložek joined by Michelle Bunton, Elvira Hufschmid, Sunny Kerr, Nadia Lichtig, and Zac Kenny
Photo: Zoom

The invitation—from Jan Allen and Sunny Kerr—to take part in the presentation of *Drift: Art and Dark Matter* exhibition became an intriguing prompt for us, an academically-situated Art Museum at the University of Toronto, to talk more about how art and science relate to the world, where they meet and depart from each other, or how artists and scientists think about the wonder they might have in common. We were exceptionally lucky to have Hana Nikĉevic in the position of Public Programming and Outreach Assistant, work with us, facilitated by the Young Canada Works program.

Drift: Art and Dark Matter was presented from 11 May to 22 October 2022, and programming kickstarted with Sunny Kerr's Curatorial Tour on September 17. Hana organized *Dark Matter and Metaphor: A Panel Discussion on Art and Astrophysics*, on September 21, online, which asked: how, in what ways, can ideas from the sciences be extrapolated and brought to bear on our world at large? What might art, likewise, offer to the sciences? Speakers included Renée Hložek, Assistant Professor of Astrophysics at UofT, who studies a variety of problems in theoretical and observational cosmology. She was joined by Miriam Diamond, Assistant Professor of Astroparticle Physics; David Curtin, Assistant Professor in UofT's Department of Physics and Canada Research Chair in Theoretical Particle Physics, and Elvira Hufschmid, a multimedia artist and a doctoral candidate in Cultural Studies at Queen's University. The panel was followed by a lecture, a week later, by Karen Barad, Distinguished Professor of Feminist Studies, Philosophy, and History of Consciousness at the University of California at Santa Cruz, on touch and alterity in "On Touching the Stranger Within—Material Wonderings/Wanderings." Artist Jol Thoms joined Karen in conversation to probe their interests further, on Wednesday, September 28.

Still residing on our website, as part of our Virtual Spotlight series, is an essay by Paige Hirschey, then Ph.D. Candidate in Art History at UofT, titled "'Two Moons?': The Shifting Terrain of Art and Science."1 Invited by Hana Hana Nikĉevic, the essay was published online on September 26, inquiring as to how the scientific moon—as explored by science and lunar spacecraft—would relate the moon as explored through the work of artists, poets, and musicians, to follow the line of thinking in the exhibition that experiential and metaphorical practices are equally necessary, albeit different, ways of knowing.

Photo: Zac Kenny

MELANIE O'BRIAN is Acting Director and Associate Director / Curator of the Morris and Helen Belkin Art Gallery at the University of British Columbia in Vancouver.

1 artmuseum.utoronto.ca/virtual-spotlight/two-moons-the-shifting-terrain-of-art-and-science

BARBARA FISCHER is the Executive Director/Chief Curator of the Art Museum at the University of Toronto.

Drift: Art and Dark Matter
Edited by Sunny Kerr

This book extends the research trajectory initiated in 2018 by Agnes Etherington Art Centre, Arthur B. McDonald Canadian Astroparticle Physics Research Institute and SNOLAB. It accompanies *Drift: Art and Dark Matter* at Agnes Etherington Art Centre and its iterations hosted by science and art partnerships at McDonald Institute's affiliate universities and sister museums in Ottawa, Vancouver, and Toronto: Art Museum at the University of Toronto, Carleton University Art Gallery, and Morris and Helen Belkin Art Gallery.

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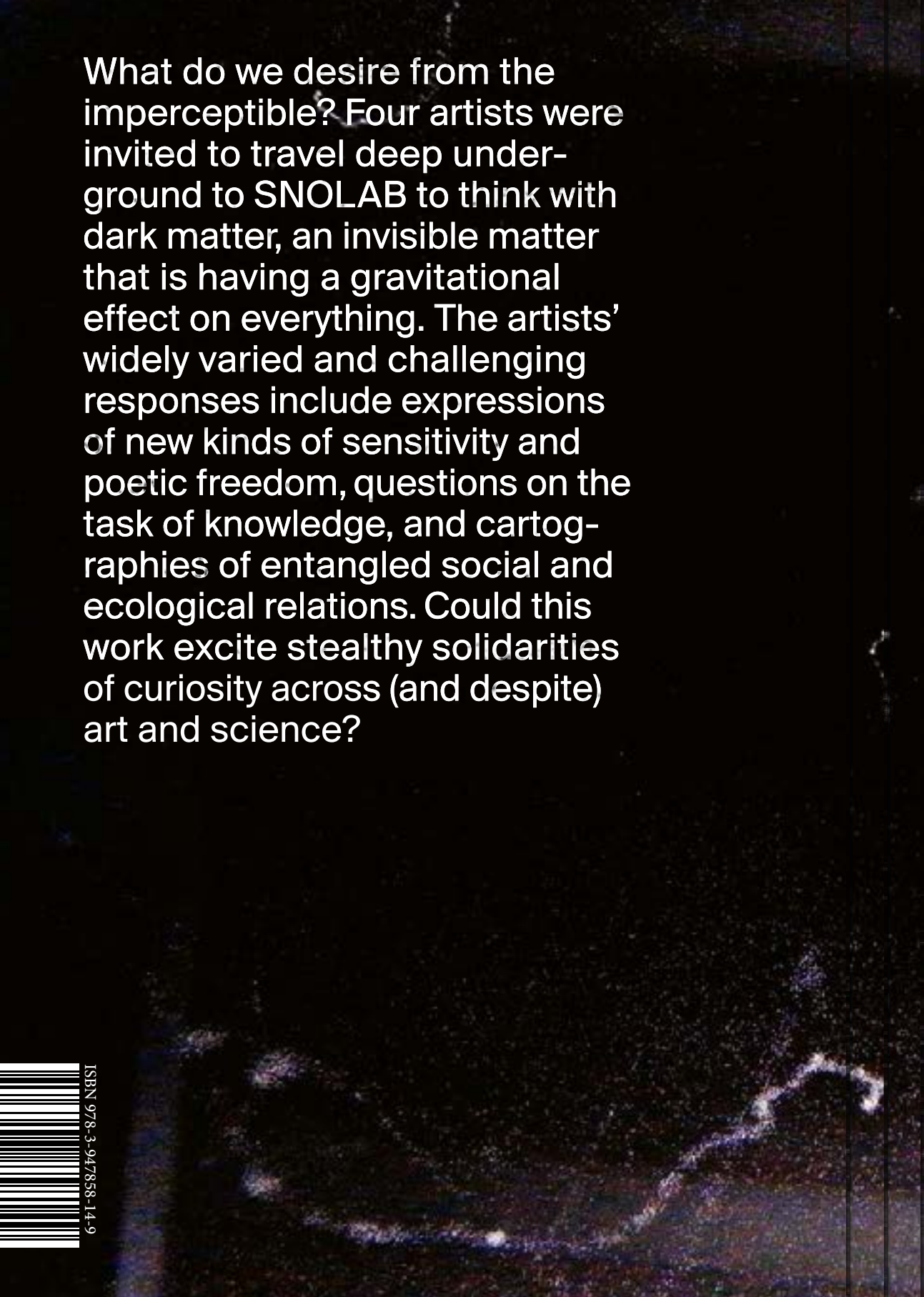
What do we desire from the imperceptible? Four artists were invited to travel deep underground to SNOLAB to think with dark matter, an invisible matter that is having a gravitational effect on everything. The artists' widely varied and challenging responses include expressions of new kinds of sensitivity and poetic freedom, questions on the task of knowledge, and cartographies of entangled social and ecological relations. Could this work excite stealthy solidarities of curiosity across (and despite) art and science?



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