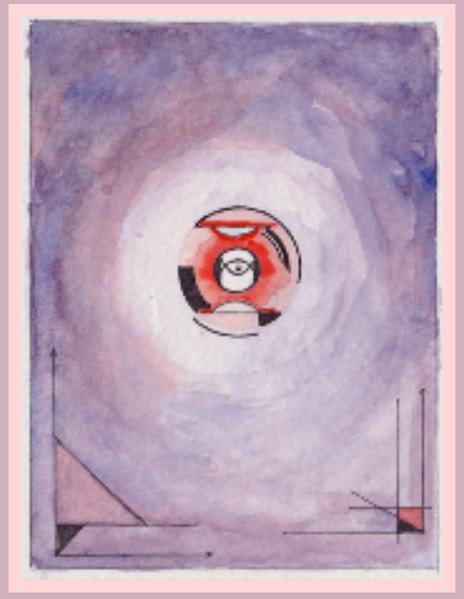
PROJECTIONS

COSMOLOGY AND THE FUTURE OF SPACETIME

ROTMAN INSTITUTE OF PHILOSOPHY
WESTERN UNIVERSITY
LONDON, ON, CANADA
JUNE 12-14, 2017



KAĆA BRADONJIĆ

www.kacabradonjic.com

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PROJECTIONS

An academic talk and the subsequent discussion is a public display of an otherwise mostly closed-door affair, and it exposes the complex nature of the creation of knowledge. *Projections* is a series of artworks aiming to give visual representation to academic talks, mostly on the topics of physics and philosophy of physics. In a way, each *Projection* is a field report of my experience of a talk, which itself is a multidimensional beast existing in a space that exceeds the four-dimensional confines of a conference room. The talk is diffracted by my own sensibilities and projected onto the paper in real time. Some pieces are the projections of the abstract conceptual world of our models of reality and their symbolic representations: String, Loop, Set; Zero, Asymptotic, Infinity; State, Superposition, Entanglement. Others capture the emotional and the social dimensions of the talk: Enthusiasm, Self-doubt, Bravado; Camaraderie, Conflict, Agreement; Confusion, Insight, Understanding. Most of the *Projections*, however, are half-profiles: Confinement, Freedom, Exclusion; Interaction, Interference, Perturbation; Uncertainty, Confidence, Safety.

CONFERENCE INFORMATION

Cosmology and the Future of Spacetime
Rotman Institute of Philosophy
London, ON, Canada
June 12-14, 2017

Even though general relativity has enjoyed profound success throughout the century since its discovery, there are at least two reasons to think that it may have to undergo small, albeit possibly profound, revisions. One reason, essentially uncontroversial, is the open problem of how to unify general relativity with quantum theory, while the second reason, essentially controversial, regards whether certain dynamical anomalies in astronomy and cosmology are best explained in terms of new, otherwise undetected forms of matter, or in terms of a modification of gravitational theory.

We will explore these two themes from a more specific angle. In particular, the conference speakers will address the issue of "spacetime emergence" within certain approaches to quantum gravity in a cosmological setting. If, as is usually taken to be the case, general relativity breaks down as a classical initial singularity is approached, what could this mean for the view of spacetime as emergent in the early universe? Does the thermodynamic arrow of time require treating initial and final singularities differently and thereby impose fundamental constraints on the structure of a future theory of quantum gravity? More generally, what could in principle even be meant by a physical theory without at least some underlying notion of spacetime?

Similarly, if the path is pursued of modifying general relativity (MOND, TeVeS, f(R), torsion, etc.) in order to avoid the new forms of matter and/or energy that the cosmological concordance model posits, what does this mean for the lessons about matter, motion, gravity and spacetime that Einstein taught us? We will also consider recent work that clarifies the space of alternatives to general relativity, in order to assess the viability of proposals to emulate general relativity's success at length scales where it has passed stringent tests, while differing at cosmological scales.

Conference Website: https://www.philcosmo.uwo.ca/events/philosophy-of-cosmology-conference/

JUNE 12, 2017

ROBERT BRANDENBERGER, "EMERGENT SPACE AND ITS POSSIBLE OBSERVATIONAL SIGNATURES"

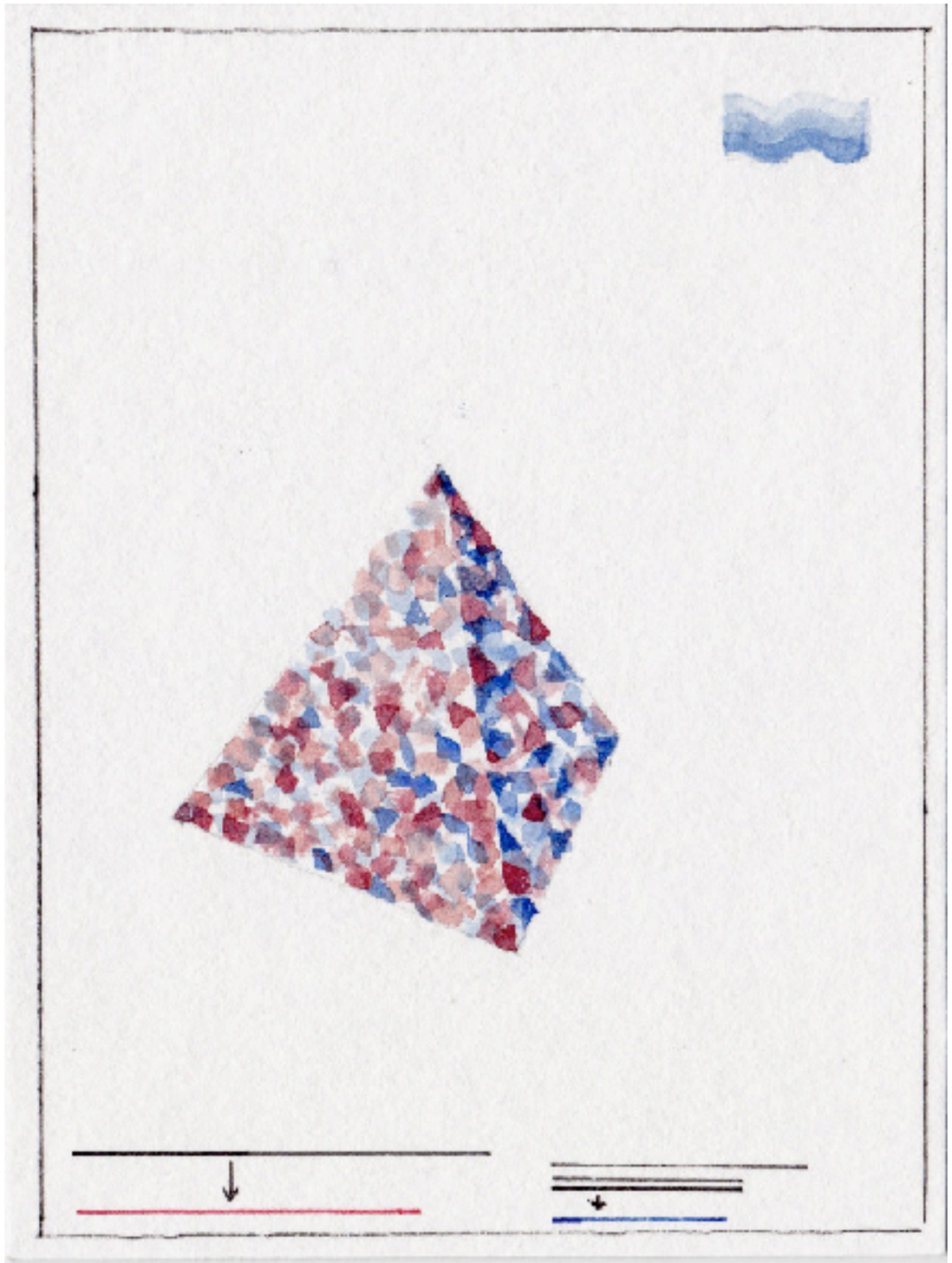
Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 11, 2017

Abstract: The physical theories which are used in cosmology break down in the very early universe. I will discuss what conditions a theory of the very early universe has to obey in order to be able to explain current observations on the large-scale structure of the universe. One class of models which obey these conditions is ``emergent cosmology''. I will explain how such a scenario could emerge from basic principles of superstring theory and how it can be tested with observations.

Video recording: https://youtu.be/_oMKH0n407M

DANIELE ORITI, "COSMOLOGY AS QUANTUM GRAVITY HYDRODYNAMICS: EMERGENT UNIVERSE WITHOUT FUNDAMENTAL SPACE AND TIME"

Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 12, 2017

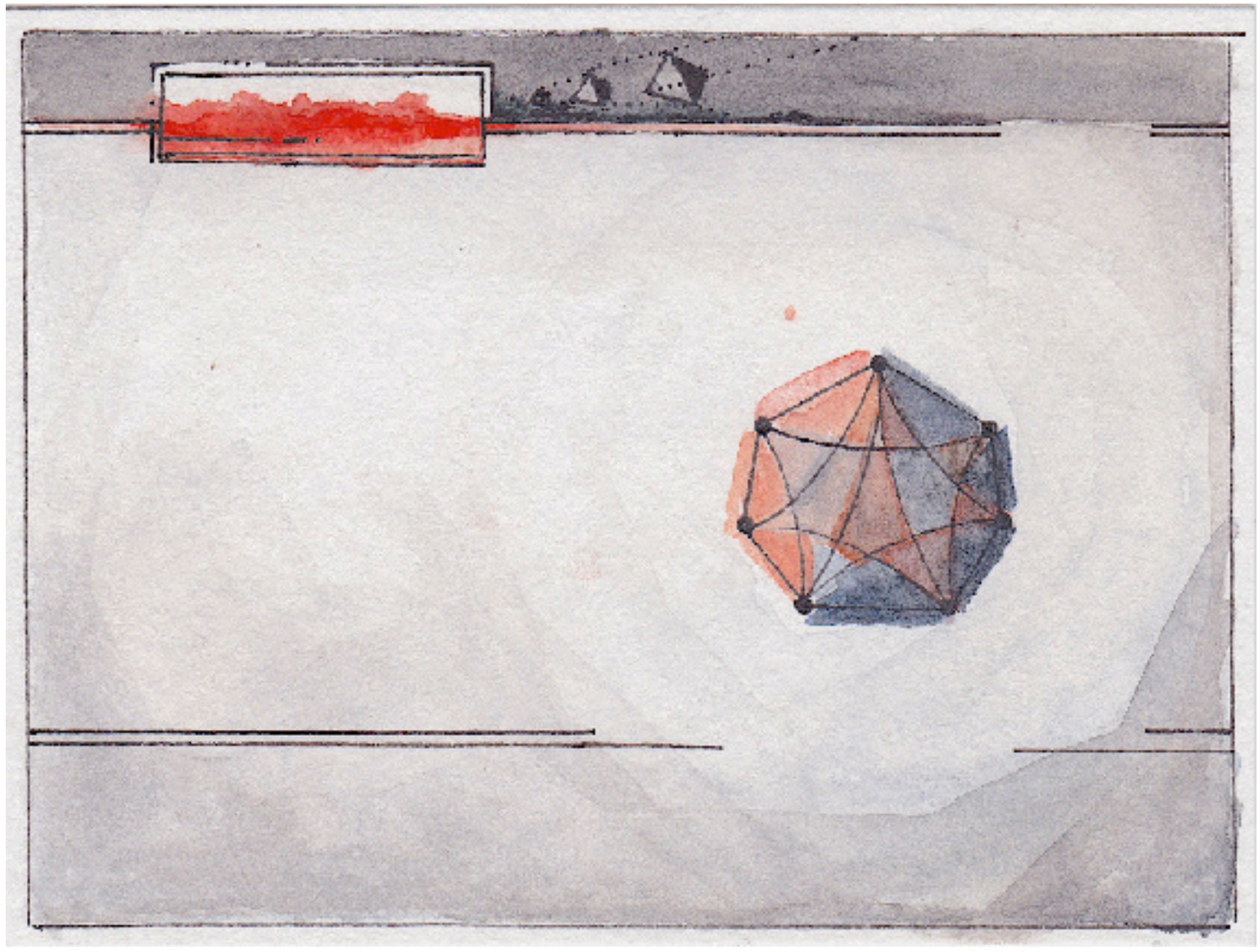


Abstract: We discuss a new perspective on the nature of cosmology from the quantum gravity point of view, and more specifically in an emergent spacetime scenario. It is based on the interpretation of cosmological dynamics as the hydrodynamic description of the microscopic quantum dynamics of the building blocks of spacetime. In this picture, the universe can be seen as sort of (quantum) fluid, the result of their collective interaction, and its cosmological description as appropriate for its coarsest approximation, close to equilibrium. Beside outlining this picture and its general implications for quantum gravity and cosmology, we also offer some examples of its realisation taken from current research in group field theory, and related quantum gravity formalisms.

Video recording: https://youtu.be/mVIWOM4QV-Q

FRANCESCA VIDOTTO, "QUANTA OF SPACETIME IN A NON-SINGULAR UNIVERSE"

Watercolor and ink on paper
4 1/2 × 5 7/8 in (11.5 × 15.1 cm)
June 12, 2017



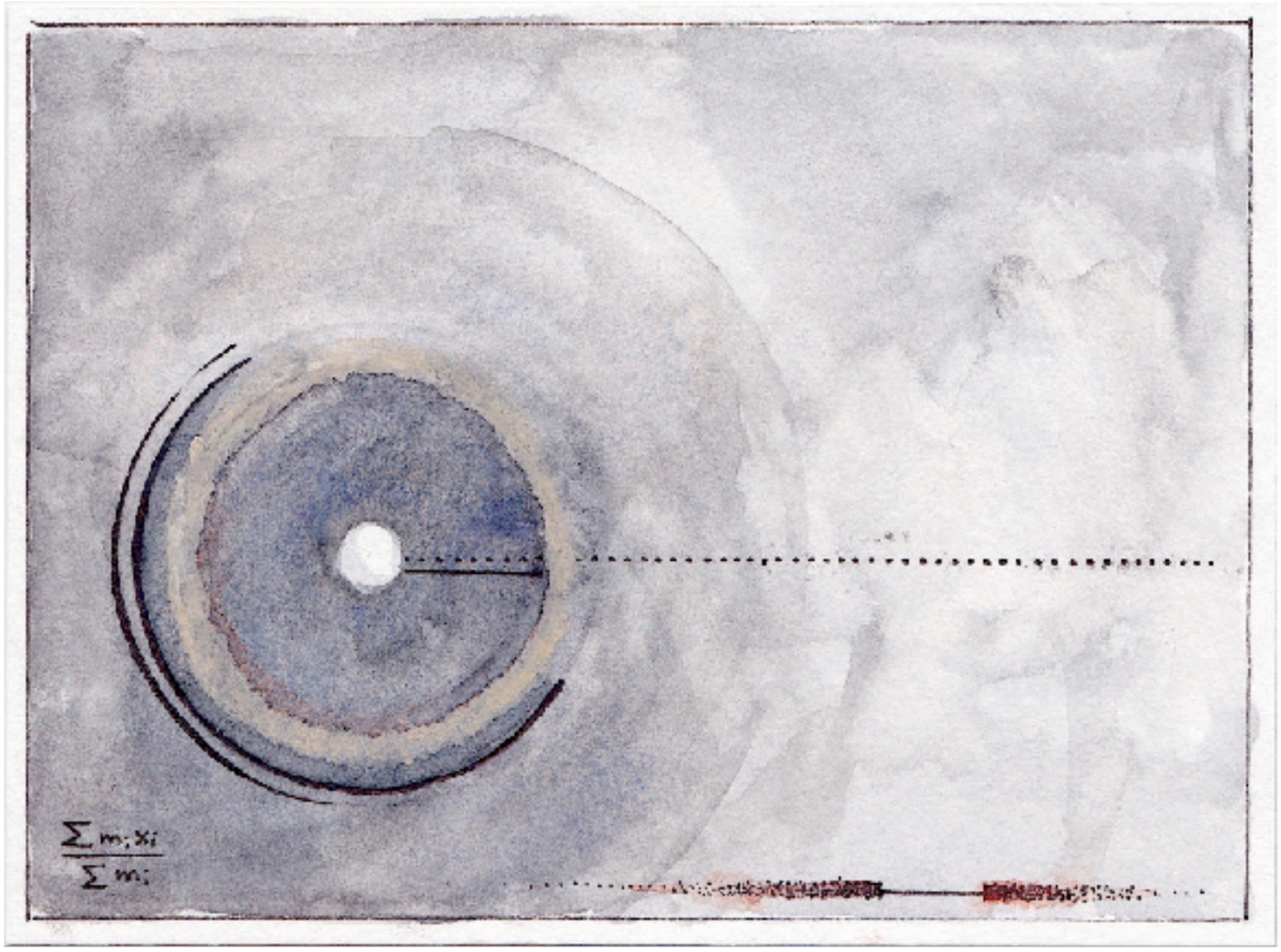
Abstract: Loop Quantum Gravity describes the dynamics of quanta of spacetime. What is the relation between those quanta and the classical spacetime? Moving from this question, I will introduce the covariant dynamics of the theory and discuss how this does not allow curvature singularities to form.

Video recording: https://youtu.be/V-PYuD6TZZY

JUNE 13, 2017

SIMON SAUNDERS, "WHAT IS SPACE-TIME GEOMETRY? — THE NON-RELATIVISTIC CASE"

Watercolor and ink on paper
4 1/2 × 5 7/8 in (11.5 × 15.1 cm)
June 13, 2017

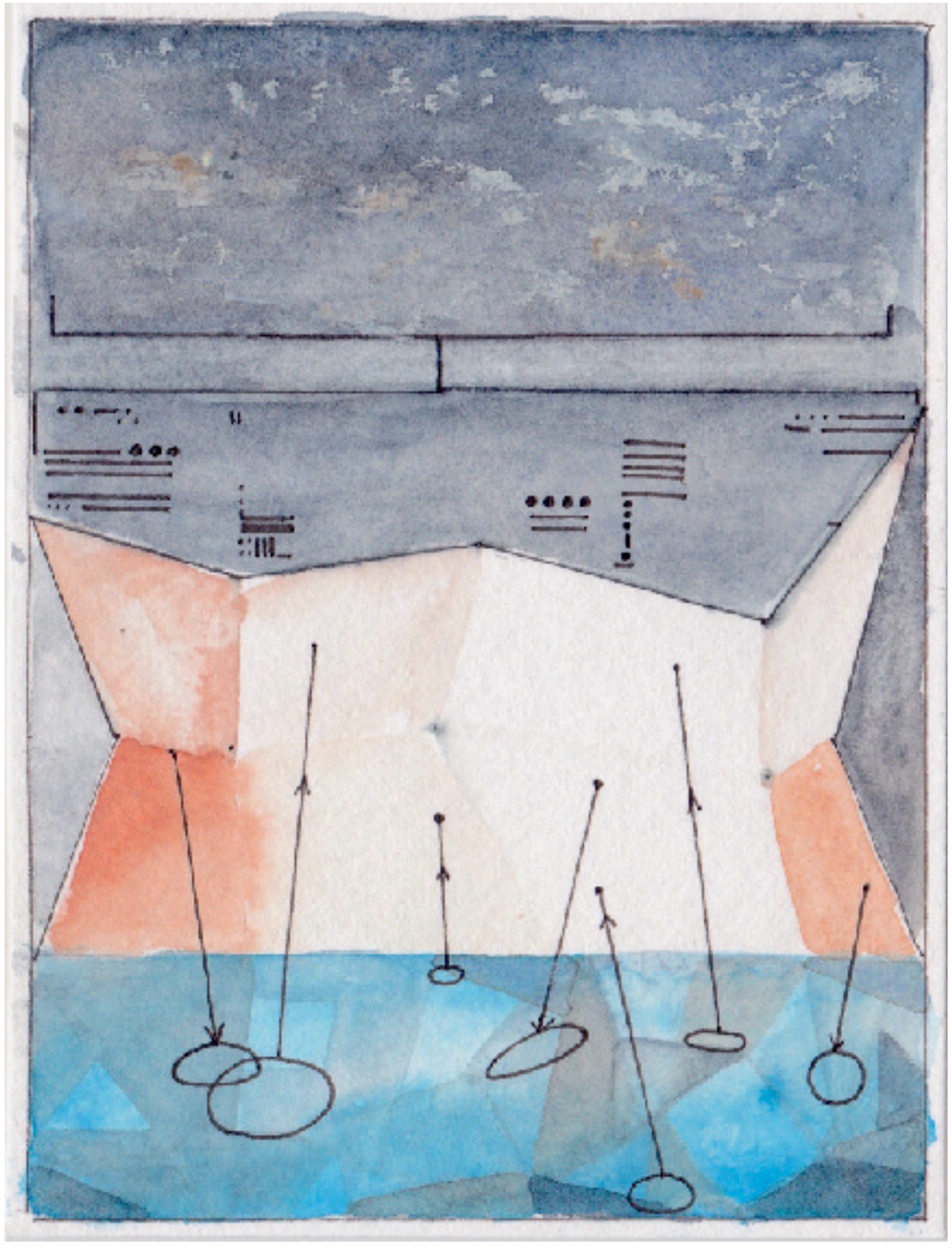


Abstract: I consider recent work of Wallace (BJPS forthcoming) on the status of inertial structure in non-relativistic classical physics, and on the underlying vector-space relationalism introduced in my 'Rethinking Newton's Principia' (PoS 2103), with particular attention to the sense or senses in which spacetime geometry is emergent or has otherwise only a functional significance, as argued by Knox in the non-relativistic case, and by Brown in special and general relativity.

Video recording: https://youtu.be/lioYaJS1KT8

TESSA BAKER, "AGNOSTIC TESTS OF GRAVITY"

Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 13, 2017

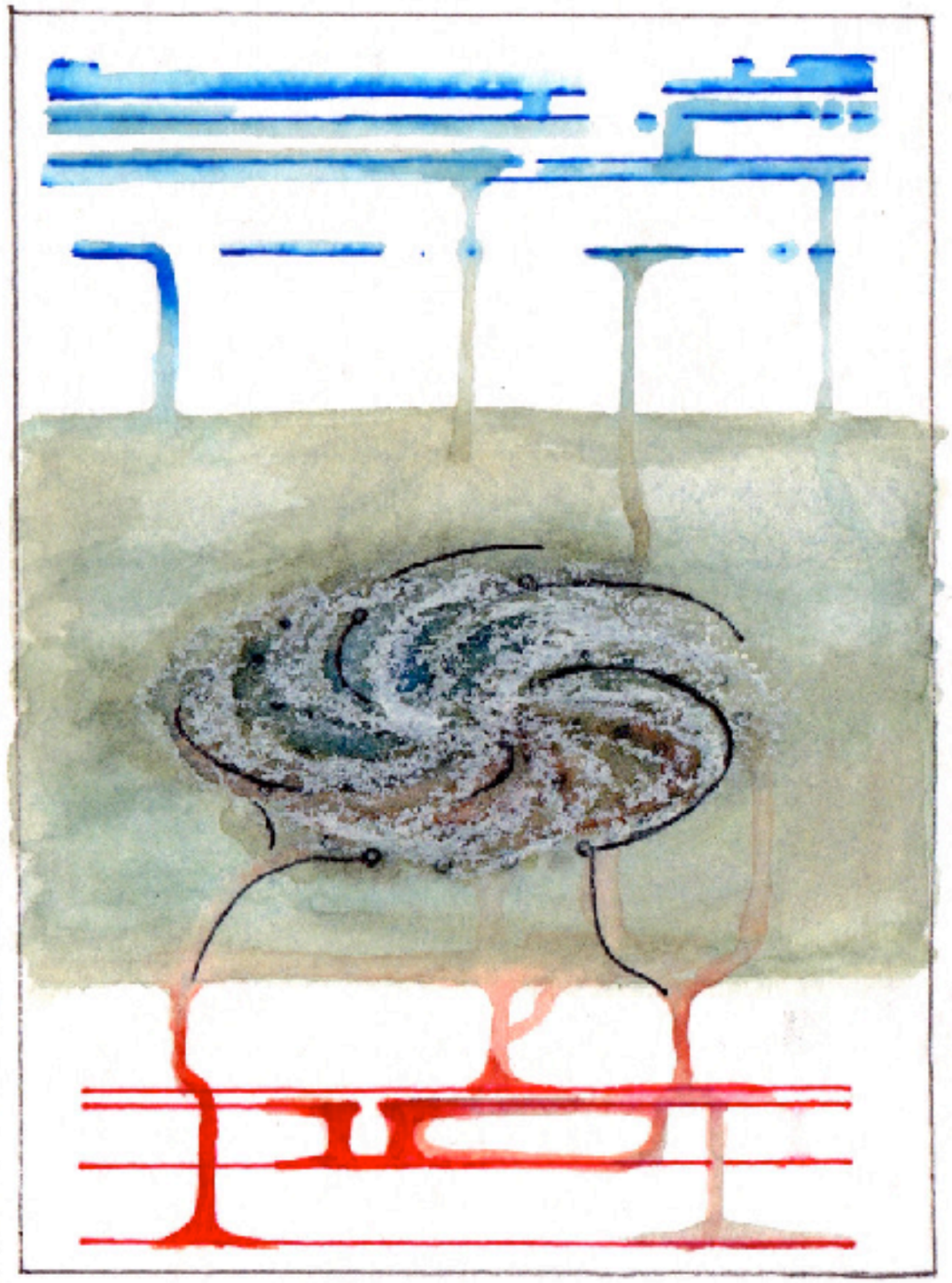


Abstract: I'll introduce the plethora of alternative gravity theories currently under discussion by cosmologists, using Lovelock's theorem as a useful way to classify them. This proliferation of theories motivates us to develop model-independent, agnostic tools for testing this theory space with cosmological data. I'll introduce the effective field theory for cosmological perturbations, a framework designed to unify modified gravity theories in terms of a manageable set of parameters. Having outlined the formalism, I'll talk about the constraints we expect to obtain on this parameterisation with the next generation of large galaxy clustering, weak lensing and intensity mapping experiments.

Video recording: https://youtu.be/cxzlOK135qg

MICHELA MASSIMI, "THREE PROBLEMS ABOUT MULTI-SCALE MODELLING IN CONTEMPORARY COSMOLOGY"

Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 13, 2017



Abstract: Scientific modelling is often tied to particular scales, and in recent times philosophers of science have investigated some of the methodological challenges multi-scale modelling faces. Batterman, for example, refers to the "tyranny of scales" and advocates the importance of modelling 'in between' scales as an alternative to what he regards as a mistaken reductionist picture. In this talk, I discuss three challenges faced by contemporary cosmology at the meso scale of galaxies, and I review the respective performance of rival approaches (ΛCDM, MOND, GMOND, EG) in satisfactorily modelling 'in between' scales.

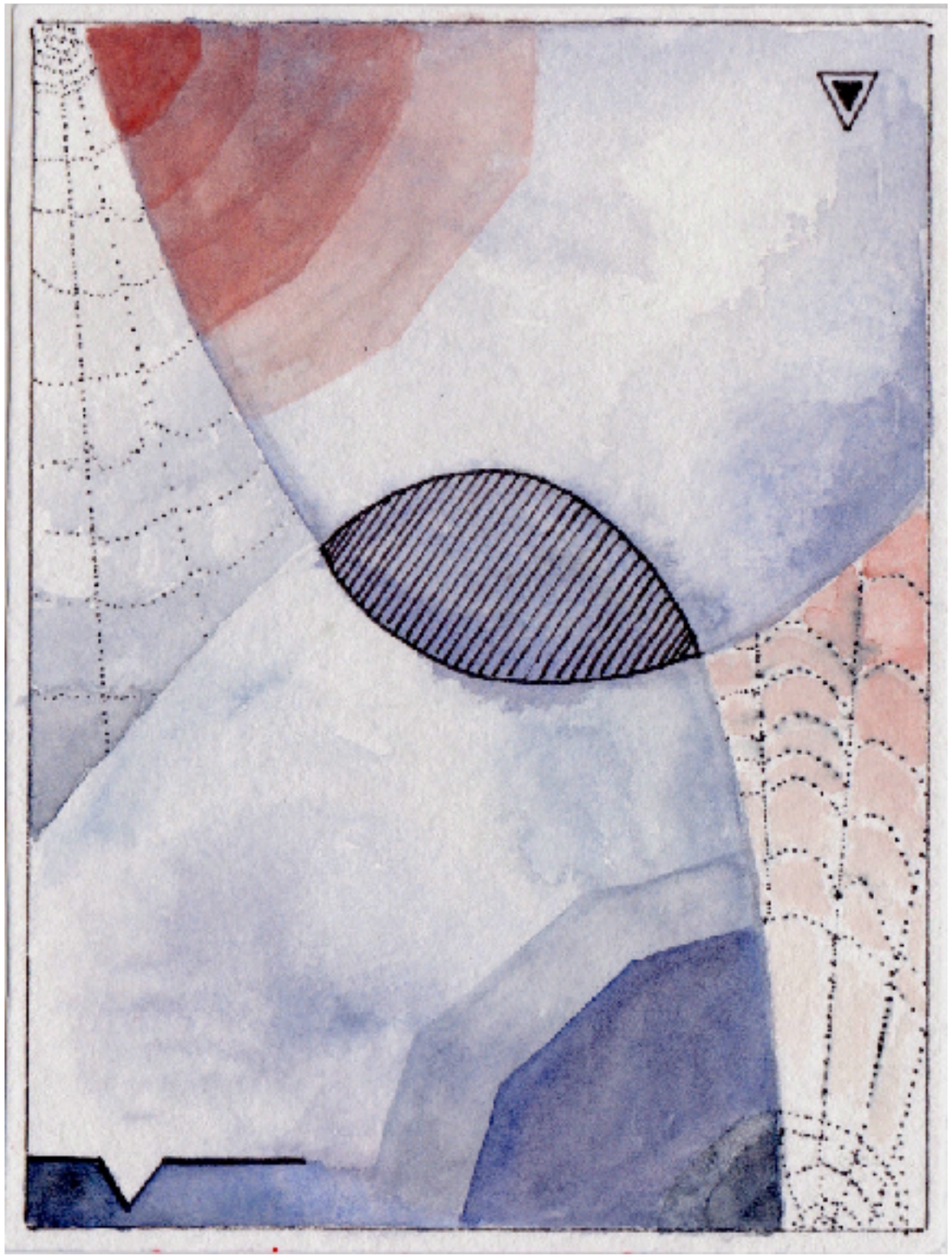
Video recording: N/A

KAREN CROWTHER, "EMERGENCE, REDUCTION, AND CORRESPONDENCE IN THE CONTEXT OF QUANTUM GRAVITY"

Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 13, 2017

Abstract: An acceptable theory of quantum gravity (QG) must recover general relativity (GR) in the regimes where GR is known to be successful. What this recovery amounts to, however, is an open question, and concerns the inter-theory relations of correspondence, reduction, and emergence. Depending on the form of the theory, these relations may also play a role in connecting QG to the framework of quantum field theory, and to particular quantum field theories. In this talk, I explore these three inter-theory relations both in general, and from the tentative perspectives of particular approaches to QG. I argue that it is important to clearly articulate and distinguish these relations, since they are each useful in different ways for understanding QG and current physics---perhaps most significantly, they are expected to play a non-trivial role in defining what would count as a successful theory of QG.

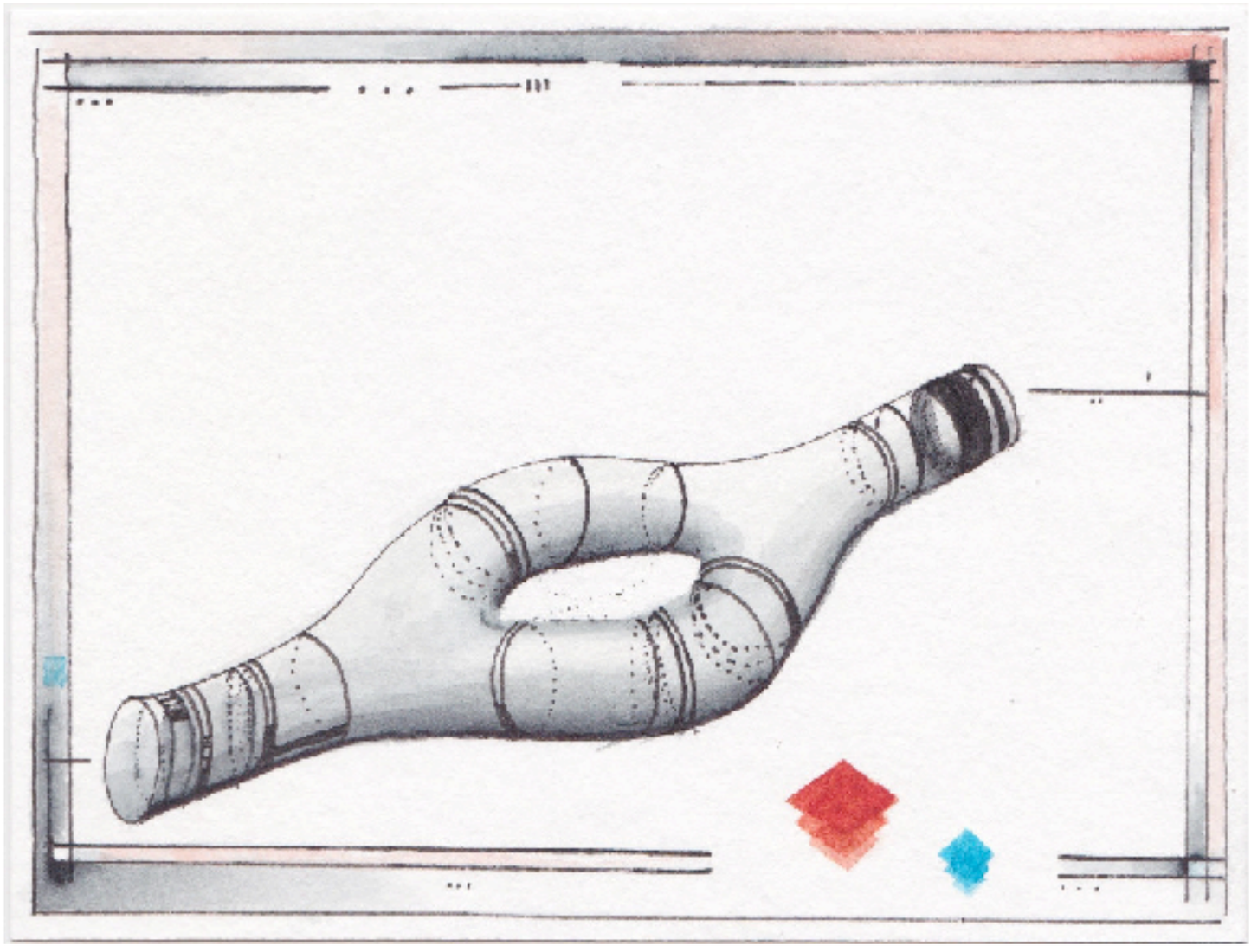
Video recording: https://youtu.be/XhX2-sdxyRI



JUNE 14, 2017

NICK HUGGETT, "COSMOLOGICAL ASPECTS OF QUANTUM GRAVITY"

Watercolor and ink on paper
4 1/2 × 5 7/8 in (11.5 × 15.1 cm)
June 14, 2017

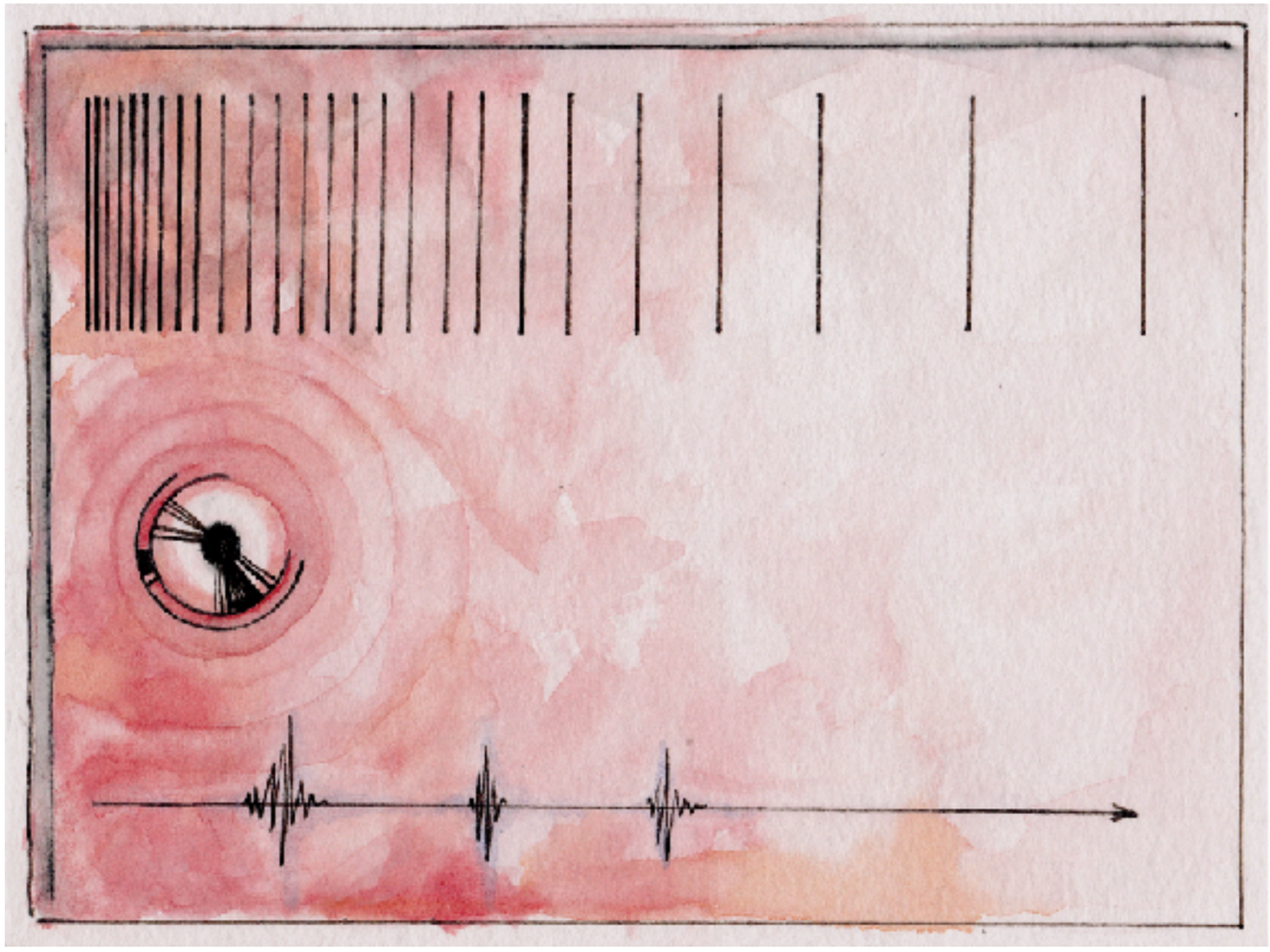


Abstract: Theories of quantum gravity can put pressure on classical notions of spacetime, and perhaps even dissolve it altogether. Not only does this circumstance require one to 'derive' spacetime as a higher level object, but (as Oriti has emphasized) perhaps opens the possibility that there was a transition from an entirely non-spatiotemporal phase in the early universe, replacing the big bang singularity. In this talk I will discuss some big bang scenarios in quantum gravity, and ask whether they fit this picture: and to the extent that they do, I will point out some of the philosophical issues that they raise.

Video recording: https://youtu.be/c2RqTj0QlH0

NIAYESH AFSHORDI, "REFLECTIONS ON SPACETIME"

Watercolor and ink on paper
4 1/2 × 5 7/8 in (11.5 × 15.1 cm)
June 14, 2017

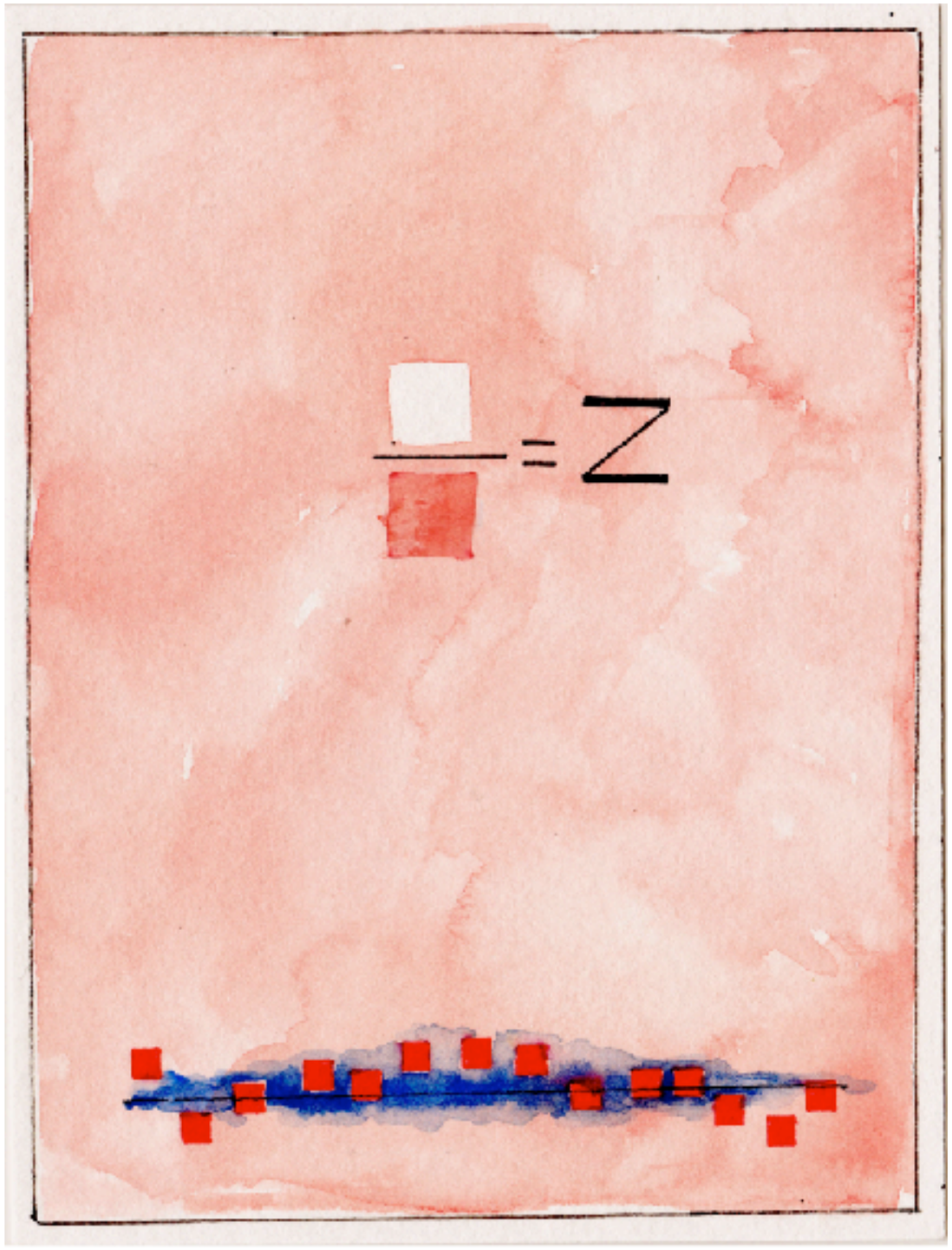


Abstract: I outline why I think convergence of empirical evidence and theoretical insights from particle physics, astrophysics, and cosmology point to a concrete and more fundamental paradigm for spacetime.

Video recording: https://youtu.be/_J5_SFg6d0w

LEE SMOLIN, "GALAXY ROTATION CURVES: MISSING MATTER, OR MISSING PHYSICS?"

Watercolor and ink on paper
5 7/8 × 4 1/2 in (15.1 × 11.5 cm)
June 14, 2017



Abstract: N/A

Video recording: https://youtu.be/Y5SvUaMw_eA

THE AUTHOR

Kaća Bradonjić is a visual artist and an Assistant Professor of Physics at Hampshire College, Amherst, MA.