Is Milgrom's MOdified Newtonian Dynamics (MOND) fundamental for philosophy, science, and the physical interpretation of string theory?

ABSTRACT

This essay raises questions concerning what is fundamental in physics. There is a brief discussion of Milgrom's MOdified Newtonian Mechanics with two possible interpretations: one possible interpretation in terms of string theory with the finite nature hypothesis and another possible interpretation in terms of string theory with the infinite nature hypothesis.

WHAT IS MOST FUNDAMENTAL IN PHILOSOPHY AND SCIENCE?

What is fundamental in the natural world? What is fundamentally good? What is fundamentally true? Is there a unified theory of philosophy and science?

According to Francis Crick, "The job of theorists, especially in biology, is to suggest new experiments. A good theory makes not only predictions, but surprising predictions that then turn out to be true. (If its predictions appear obvious to experimentalists, then why would they need a theory?)" [1]

What should a theorist try to do? What is fundamental in philosophy and physics? If you are confronted with a thing, entity, or idea, then should you ask yourself the following three questions? What is good about it? What is bad about it? Why is it important?

IS MILGROM'S MOND EMPIRICALLY VALID?

According to David Spergel, "Both dark matter and dark energy require extensions to our current understanding of particle physics or point toward a breakdown of general relativity on cosmological scales." [2]

According to Kroupa, Pawlowski, and Milgrom, "Cosmological models that invoke warm or cold dark matter can not explain observed regularities in the properties of dwarf galaxies, their highly anisotropic spatial distributions, nor the correlation between observed mass discrepancies and acceleration. These problems with the standard model of cosmology have deep implications, in particular in combination with the observation that the data are excellently described by Modified Newtonian Dynamics (MOND)." [3]

According to McGaugh and Milgrom, “MOND appears to be in good agreement with the observed velocity dispersions of the dwarf spheroidals of M31.” [4]

If the empirical successes of MOND require a new paradigm for the foundations of physics, then should there also be a new paradigm in mathematics?

MOCHIZUKI’S IUT, ALGEBRAIC GEOMETRY, AND THE AXIOMATIC CONTINUUM

How might theoretical physics, differential geometry, and algebraic geometry be related? How might the concepts of time and energy be introduced into algebraic geometry? I conjecture that there is a unified theory of mathematics and theoretical physics somehow combining Mochizuki’s IUT with the string landscape. I conjecture that there are 3 levels of mathematics and physics: (1) the mathematics of classical field theory from Euclid to Riemann with Maxwell’s equations and Einstein’s field equations; (2) the mathematics of quantum field theory from Hilbert to Grothendieck with quantum electrodynamics and the Standard Model of particle physics; (3) the mathematics of string theory from Nambu to Mochizuki with explanations of dark matter and dark energy. Am I wrong about the 3 levels? My guess is that the 1st level deals with transformational properties of covariant and contravariant vectors, the 2nd level deals with transformational properties of covariant and contravariant functors with a fixed axiomatic continuum (i.e. a logical universe), and the 3rd level deals with higher transformational properties based on variable axiomatic continua (i.e. a logical multiverse).

According to Davide Castelvecchi, “The overarching theme of inter-universal geometry, as Fesenko describes it, is that one must look at whole numbers in a different light — leaving addition aside and seeing the multiplication structure as something malleable and deformable. Standard multiplication would then be just one particular case of a family of structures, just as a circle is a special case of an ellipse. Fesenko says that Mochizuki compares himself to the mathematical giant Grothendieck — and it is no immodest claim.” [5]

According to Minhyong Kim, "From Mochizuki's point of view, it's all about looking for a more fundamental reality that lies behind the numbers. Many more things are related at an abstract level than they are at a concrete level.” [6]

HOW DID THE BIG BANG BEGIN?

According to Edward Witten, “String theory is the only known generalization of relativistic quantum field theory that makes sense.” [7]

For understanding the fundamental mechanisms of how the big bang started, is string theory a necessity? If, after quantum averaging, Einstein field equations are 100% correct, then our universe expands forever and it seems likely that the big bang started as a huge quantum fluctuation in the quantum vacuum. However, is there a real possibility that Newtonian-Einsteinian gravitational theory is slightly wrong? If time is finite, then can our universe expand forever?

FREDKIN’S PHILOSOPHY

According to Robert Wright, “… Fredkin is one of those people who arouse either affection, admiration, and respect, or dislike and suspicion. The latter reaction has come from a number of professors at MIT, particularly those who put a premium on formal credentials, proper academic conduct, and not sounding like a crackpot. ... Fredkin doubts that his ideas will achieve widespread acceptance anytime soon. He believes that most physicists are so deeply immersed in their kind of mathematics, and so uncomprehending of computation, as to be incapable of grasping the truth. Imagine, he says, that a twentieth-century time traveler visited Italy in the early seventeenth century and tried to reformulate Galileo's ideas in terms of calculus. Although it would be a vastly more powerful language of description than the old one, conveying its importance to the average scientist would be nearly impossible. There are times when Fredkin breaks through the language barrier, but they are few and far between. He can sell one person on one idea, another on another, but nobody seems to get the big picture. It's like a painting of a horse in a meadow, he says. "Everyone else only looks at it with a microscope, and they say, 'Aha, over here I see a little brown pigment. And over here I see a little green pigment.' Okay. Well, I see a horse.” Fredkin’s research has nevertheless paid off in unanticipated ways.” [8]

According to Edward Fredkin, “Digital Philosophy (DP) is a new way of thinking about how things work. ... DP is based on two concepts: bits, like the binary digits in a computer, correspond to the most microscopic representation of state information; and the temporal evolution of state is a digital information process similar to what goes on in the circuitry of a computer processor.” [9]

WHAT MIGHT BE THE IMPLICATIONS OF FREDKIN’S FINITE NATURE HYPOTHESIS?

How might Wolfram's cosmological automaton make sense in terms of physics? My guess is that there is a unique model for string theory with the finite nature hypothesis, and this unique model can be embedded in various ways into models of string theory with the infinite nature hypothesis — the key idea is to replace supersymmetry by MOND-compatible supersymmetry so that Wolframian pseudo-supersymmetry can be embedded into various models of MOND-compatible supersymmetry. Is the main problem with string theory the failure of string theorists to realize that Milgrom is the Kepler of contemporary cosmology?

Consider 9 conjectures:

(1) String theory with the finite nature hypothesis implies MOND and the 64 Particles Hypothesis.

(2) The Koide formula is essential for understanding string theory with the finite nature hypothesis.

(3) String vibrations are confined to 3 copies of the Leech lattice.

(4) There are 6 basic quarks because there are 6 pariah groups.

(5) The monster group and the 6 pariah groups allow energy to exist.

(6) There exists a (2/3)-Koide formula that allows some quarks to have charge ± 2/3.

(7) There exists a (1/3)-Koide formula that allows some quarks to have charge ± 1/3.

(8) Time exists because 2^46 divides the order of the monster group.

(9) Space exists because 3^20 divides the order of the monster group.

Does string theory with the finite nature hypothesis imply MOND and no supersymmetry?

Consider 3 conjectures: (1) Milgrom is the Kepler of contemporary cosmology, and the empirical validity of Milgrom's MOdified Newtonian Dynamics (MOND) requires a modification of Einstein's field equations. (2) The Koide formula suggests that there might be a modification of Einstein's field equations. (3) Lestone's heuristic string theory suggests that there might be a modification of Einstein's field equations. What might be the implications if the 3 preceding conjectures? I suggest that there might be 3 possible modifications of Einstein's field equations. Consider Einstein's field equations: R(mu,nu) + (-1/2) * g(mu,nu) * R = - κ * T(mu,nu) - Λ * g(mu,nu) — what might be wrong? Consider the possible correction R(mu,nu) + (-1/2 + dark-matter-compensation-constant) * g(mu,nu) * R * (1 - (R(min) / R)^2)^(1/2) = - κ * (T(mu,nu) / equivalence-principle-failure-factor) - Λ * g(mu,nu), where equivalence-principle-failure-factor = (1 - (T(mu,nu)/T(max))^2)^(1/2) — if dark-matter-compensation-constant = 0, R(min) = 0, and T(max) = +∞ then Einstein's field equations are recovered. This brief communication offers 3 criticisms involving physical assumptions used by Einstein when he formulated his field equations. An easy scaling argument shows that taking dark-matter-compensation-constant = sqrt((60±10)/4) * 10^-5 yields an approximation to MOND. Did the Gravity Probe B science team misinterpret their own experiment?

MILGROM, KOIDE, AND LESTONE

What might be 4 important questions concerning the foundations of physics? Is Milgrom the Kepler of contemporary cosmology? [10] Is the Koide formula essential for understanding the foundations of physics? [11] Is Lestone's theory of virtual cross sections essential for understanding the foundations of physics? [12], [13] How might the foundations of physics be modified?

EINSTEIN'S "THE MEANING OF RELATIVITY", 5TH EDITION, PAGES 83 AND 84

[edit note: for page 83, all except last paragraph of page 83 deleted]

If there is a analogue of Poisson's equation in the general theory of relativity, then this equation must be a tensor equation for the tensor g(mu,nu) of the gravitational potential; the energy tensor of matter must appear on the right-hand side of this equation. On the left-hand side of the equation there must be a differential tensor in the g(mu,nu). It is completely determined by the following three conditions:

1. It may contain no differential coefficients of the g(mu,nu) higher than the second.

2. It must be linear in these second differential coefficients.

3. Its divergence must vanish identically.

The first two of these conditions are naturally taken from Poisson's equation. Since it may be proved mathematically that all such differential tensors can be formed algebraically (i.e. without differentiation) from Riemann's tensor, our tensor must have the form

R(mu,nu) + a g(mu,nu) R

in which R(mu,nu) and R are defined by (88) and (89) [edit note: see page 77]. Further, it may be proved that the third condition requires a to have the value – 1/2 . For the law of the gravitational field we therefore get the equation

(96)   R(mu,nu) – (1/2) g(mu,nu) R = – κ * T(mu,nu) .

Equation (95) [edit note: see deleted part of page 83] is a consequence of this equation. κ denotes a constant, which is connected with the Newtonian gravitational constant. [14]

CRITICISMS OF EINSTEIN'S ASSUMPTIONS

Condition 2 assumes that scaling is perfect with respect to R. If R ≥ R(min) uniformly for some positive constant R(min), then Condition 2 is not satisfied. The Koide formula suggests that squareroot(mass-energy) might somehow be construed as area. If so, the entire universe might undergo an instantaneous (i.e. one Planck time interval) collapse. If the universe collapses when the average temperature of the universe gets too cold, then Einstein was wrong.

Condition 3 assumes that gravitational energy is conserved in the Newtonian approximation. Milgrom's MOND suggests that gravitational energy might not be conserved.

The assumption that the energy-density is faithfully represented by a tensor might not true. If scaling is not perfect with respect to the energy tensor T(mu,nu) then the assumption might break down if the energy-density is sufficiently large. Lestone's heuristic string theory perhaps suggests that energy-density is not faithfully represented by a tensor at the Planck scale — even after quantum averaging.

HYPOTHESIS OF NON-CONSERVATION OF GRAVITATIONAL ENERGY

Photons and gluons cannot escape from the universe in which they are located. Gravitons travel at the speed of light on average. A statistically significant few gravitons travel slower than the speed of light. These slow gravitons cause the Fernández-Rañada-Milgrom effect. A statistically few gravitons travel faster than the speed of light and escape from the boundary of the multiverse into the interior of the multiverse. These fast gravitons cause the nonzero cosmological constant and the inflaton field. Electromagnetic radiation from the inflaton field shows up as the space roar. If the fast gravitons never escaped from the universe in which they are located, then the slow gravitons and the fast gravitons would average out, yielding Einstein's field equations with cosmological constant = zero and dark-matter-compensation-constant = zero.

WHAT IS THE DIMENSION OF SPACETIME?

Define matter time as time measured by a clock made from matter. Define antimatter time as time measured by a clock made from antimatter. Is spacetime 4-dimensional? Is spacetime 26-dimensional? Measurements of spacetime using clocks and surveying instruments demonstrate that spacetime is 4-dimensional. I say that, from one point of view, spacetime is 26-dimensional. 26 dimensions = 1 dimension of matter time + 1 dimension of antimatter time + 24 dimensions of (±, ±, ±)-space. What is (±, ±, ±)-space? For the measurement of space, employ 6 particle beams consisting of 3 electron beams and 3 positron beams. For each dimension of space, employ all 3-tuples of beams selected from the 6 beams. By definition, (±, ±, ±)-space consists of 3 dimensions of ordinary space, in which the x-axis can be thought as 8-dimensional because it is measured in 8 different ways by using all of the possible 3-tuples of the 6 beams; and likewise for the y-axis and the z-axis. The 24 dimensions of (±, ±, ±)-space reduce to the 3 dimensions of ordinary space because quantum field theory is empirically valid — however, (±, ±, ±)-space might be useful for representational redundancy (because of the role that the Leech lattice plays in the foundations of physics.)

IS NATURE INFINITE?

My basic theory is string theory with the finite nature hypothesis plus simplifying assumptions. The three most important implications of my basic theory are the alleged Fernández-Rañada-Milgrom effect, the 64 Particles Hypothesis, and the Space Roar Profile Prediction. If one of the three predictions is wrong, then I guess that all three predictions are wrong. If nature is infinite, then I make 3 alternate guesses: (1) After quantum averaging, Einstein's field equations are 100% correct. (2) Magnetic monopoles were important in the early universe. (3) Some form of supersymmetry is correct, and all of the superpartners of particles in the Standard Model are MOND-chameleon particles that have variable effective mass depending on nearby gravitational acceleration.

STRING THEORY AND DARK MATTER

According to Sunil Mukhi, "The role of duality in string theory was a unifying one. Apparently different compactifications of different 10-dimensional string theories were related by conjectured duality transformations for which stringent tests were proposed. String theory passed all the tests, and in each case did so by strikingly different dynamical mechanisms. During this period, it became more clear than ever that the underlying structure of string theory was very rigid and constrained, and that dualities were an intrinsic and deep property built into the theory." [15]

According to S. James Gates, Jr., "One of the most commonly cited problems with the Standard Model is that it lacks a compelling reason to introduce new elementary particles, such as WIMPs (weakly interacting massive particles), that could account for the behaviour of dark matter. The presence of so many superpartners in the MSSM provides a logical — indeed almost compelling — solution to this problem …" [16]

SUPERSYMMETRY WITH LESTONE'S THEORY OF VIRTUAL CROSS SECTIONS

How might supersymmetry be combined with new physical hypotheses?

John P. Lestone of Los Alamos National Laboratory has suggested a theory of quantum micro black holes that might explain the value of the fine structure constant. He suggested 7 principles, the first 4 of which are as follows: "Properties used to calculate the fine structure constant for my imaginary particles (1) My particles have a very high temperature. (2) Despite having a high temperature my imaginary particles can not change their rest mass upon the emission of electromagnetic energy. Using known physics my imaginary particles (if isolated) can not emit any "real" photons. (3) However, I consider the possibility that my imaginary particles can emit and absorb unphysical L=0 "virtual" photons via the time-energy uncertainty principle. (4) The emission and absorption is controlled by statistical arguments involving their assumed "classical" temperature and possibly other effective temperatures. …" [17]

Consider 10 hypotheses (partly based upon Lestone's hypotheses):

(1) The flat spacetime of quantum field theory and the curved spacetime of general relativity theory emerge from a virtual quantum foam spacetime in which massless virtual particles travel at a virtual speed C which is vastly greater than c. The virtual speed C is so large that it appears to be infinite. Virtual quantum foam spacetime is amazingly hot — so hot that ordinary spacetime decomposes into quantum foam. The non-virtual particles are the vastly cooler particles that are confined by gravitational geodesics.

(2) The virtual quantum foam spacetime is 26-dimensional. It has 3 dimensions of ordinary space, 1 dimension of time, 3 dimensions of linear momentum, 3 dimensions of angular momentum, and 16 dimensions of uncertainty. The dimensions of uncertainty arise because 4-dimensional spacetime has 4 dimensions of hbar uncertainty multiplied by 4 dimensions of alpha-prime uncertainty. The quantum foam spacetime is the physical interpretation of 26-dimensional bosonic string theory, which has 25 dimensions of higher-dimensional space and 1 dimension of time.

(3) Micro black holes with masses less than the Planck mass and with charges roughly approximated by the electron charge existed during the very early stages of the Big Bang but then rapidly evaporated down to the fundamental particles of the Standard Model and whatever massive particles might need to be added to the Standard Model.

(4) All of the fundamental particles with mass are quantum micro black holes. Massive bosons are roughly like virtual 1-spheres in quantum foam spacetime. Leptons are roughly like virtual 2-spheres. Quarks are roughly like virtual 3-spheres.

(5) Virtual photons and virtual gravitons can be exchanged between two micro black holes and there is a relevant transmission coefficient for widely separated micro black holes. Exchanges of virtual photons and virtual gravitons in quantum foam spacetime determine the strengths of the electromagnetic and gravitational fields.

(6) The conventional, widely accepted theory of quantum evaporation of micro black holes is wrong because the theory ignores the virtual cross sections of massive virtual

particles. If the virtual cross sections went to zero then the conventional theory would be correct.

(7) There is widespread transient violation of conservation of electromagnetic energy but the violation averages out to zero on time scales larger than the Planck time.

(8) The Heisenberg uncertainty principle is 100% correct for directly measured particles but for virtual particles the Heisenberg uncertainly principle needs to be replaced by an (hbar,alpha-prime) uncertainty principle which takes into account Lestone's theory of virtual cross sections.

(9) After quantum averaging, Einstein's field equations are 100% correct but the -1/2 in the standard form of Einstein's field equations is apparently replaced by -1/2 + MOND-chameleon-fake-function, where this function is caused by the presence of MOND-chameleon particles. These hypothetical MOND-chameleon particles have variable effective mass depending on nearby gravitational acceleration. Some of the MOND-chameleon particles are bosons which form a Bose-Einstein condensate. This Bose-Einstein condensate forms an insulating barrier between the cooler non-virtual particles and the vastly hotter virtual particles.

(10) There exists a virtual heat wave with a period of one Planck time interval. The virtual heat wave instantaneously de-compactifies and re-compactifies each universe in the string landscape and provides a virtual higher-dimensional space in which Lestone's 7 principles operate,

MEASUREMENT AND THE PLANCK SCALE

The physics of the Planck scale might be always controversial because of the difficulties of performing experiments involving black holes. I say that Milgrom is the Kepler of contemporary cosmology — on the basis of overwhelming empirical evidence. However, the meaning of Milgrom's MOND at the Planck scale might remain controversial far into the future.

According to Mordehai Milgrom, "Of all of the many mysteries of modern astronomy, none is more vexing than the nature of dark matter. ... This dark matter has eluded every effort by astronomers and physicists to bring it out of the shadows. A handful of us suspect that it might not really exist, and others are beginning to consider this possibility seriously." [18]

REFERENCES

[1] Francis Crick, "What Mad Pursuit", Basic Books, 2008, page 142.
http://books.google.com/books?id=azHIbT79PE8C

[2] by David N. Spergel, “The dark side of cosmology: Dark matter and dark energy”, Science, 6 March 2015. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.866.2551&rep=rep1&type=pdf

[3] Pavel Kroupa, Marcel Pawlowski, and Mordehai Milgrom. "The failures of the standard model of cosmology require a new paradigm." International Journal of Modern Physics D, Volume 21, Issue14, 2012, 1230003. https://arxiv.org/abs/1301.3907

[4] Stacy McGaugh and Mordehai Milgrom, “Andromeda Dwarfs in Light of MOND”, arXiv.org, 2013. https://arxiv.org/abs/1301.0822

[5] Davide Castelvecchi, “The biggest mystery in mathematics: Shinichi Mochizuki and the impenetrable proof”, Nature, 7 October 2016

http://www.nature.com/news/the-biggest-mystery-in-mathematics-shinichi-mochizuki-and-the-impenetrable-proof-1.18509

[6] Kevin Hartnett, "Hope Rekindled for Perplexing Proof, Quanta Magazine, 21 December 2015.

https://www.quantamagazine.org/hope-rekindled-for-abc-proof-20151221/

[7] Edward Witten, “Unravelling String Theory”, Nature, 22/29 December 2005.

http:/www.sns.ias.edu/ckfinder/userfiles/files/Unravelling.pdf

[8] Robert Wright "Did the Universe Just Happen", Atlantic Monthly, April 1988, pages 29–44.

https://www.theatlantic.com/past/docs/issues/88apr/wright.htm

[9] Edward Fredkin, “An Introduction to Digital Philosophy”, International Journal of Theoretical Physics, February 2003. http://52.7.130.124/wp-content/uploads/2015/07/intro-to-DP.pdf

[10] Mordehai (Moti) Milgrom, Department of Particle Physics and Astrophysics (website), Weizmann Institute of Science. http://www.weizmann.ac.il/particle/milgrom/

[11] Yoshio Koide, “Fermion-boson two-body model of quarks and leptons and cabibbo mixing”, Lettere al Nuovo Cimento, June 1982. http://link.springer.com/article/10.1007%2FBF02817096

[12] John P. Lestone, “Physics based calculation of the fine structure constant”, arXiv.org, 2009. https://arxiv.org/abs/physics/0703151

[13] John P. Lestone, “Semi-classical Electrodynamics: A Short Note”, Los Alamos Report LA-UR-16-27659, 5 October 2016. http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-16-27659

[14] Albert Einstein, “The Meaning of Relativity”, 5th edition, Princeton University Press, 1955, pp. 83–84

[15] Sunil Mukhi, “String theory: a perspective over the last 25 years", arXiv.org, 2011, pages 20–21.

http://arxiv.org/abs/1110.2569

[16] S. James Gates, Jr., ”Sticking with SUSY", Physics World, October 2014.

http://live.iop-pp01.agh.sleek.net/2014/09/25/sticking-with-susy/

[17] John P. Lestone, “Possible path for the calculation of the fine structure constant”, Los Alamos Report LA-UR-16-22121, 4 April 2016, page 10.
http://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-16-22121

[18] Mordehai Milgrom, “Does Dark Matter Really Exist?”, Scientific American, August 2002.

http://www.astro.umd.edu/~ssm/mond/sad0802Milg6p.pdf (Scroll past blank page.)