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Frames of Reference

Revised Expressions using Measurement Quantization (MQ)

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In MQ Form

A self-defining description of a fundamental unit of mass in terms of a count of l_f representing the radius of the universe divided by a count of t_f representing the age of the universe. The expression resolves to m_f=2.1764 E-8 kg matching the 2018 CODATA estimates.

$$m_f = \frac{n_{Lu}}{n_{Tu}}$$

Discussion

Over the past 100 years frames of reference have become central to properly resolving the observed properties of phenomena. The modern approach recognizes two frames, that of the target and that of the observer. Measurement Quantization (MQ)(3,Sec. 2.3) introduces a third frame (the inertial frame of the universe)(2,Sec. 3.4) which has always been implicit to existing descriptions, but is not always formally recognized. Without a formal approach to describing the third frame, formulating expressions can be difficult. More often, the third frame is just not recognized as a necessary component of physical description.

$$m_f = \frac{2\theta_{si} t_f}{l_f} = \frac{2\theta_{si} n_T t_f}{n_L l_f} = \frac{2\theta_{si}}{c}\frac{n_T}{n_L}$$

$$m_u = \frac{2\theta_{si}}{c}\frac{n_{Tu}}{n_{Lu}} = 1$$

$$\frac{2\theta_{si}}{c} = \frac{n_{Lu}}{n_{Tu}}$$

$$m_f = \frac{n_{Lu}}{n_{Tu}}$$

Before we begin, though, we should briefly review what MQ is and why it is important. MQ is a nomenclature(3,Sec. 2.3) applied to existing expressions in modern theory. Terms that make up expressions are each broken down into their fundamental measures(4,Eqs. 67-79) - l_f, m_f and t_f - and multiplied by a count of those measures - n_L, n_M and n_T. By example, when applying MQ to an analysis of Heisenberg's uncertainty principle(4,Eqs. 6-10) we find that all the measure terms drop out of the expression leaving only the count terms4(Eq. 10). From this we are able to resolve the values of the count terms(4,Sec. II) and the fundamental measures (4,Eqs. 67-79). We are also able to resolve three properties of measure: discreteness, countability and in reference to the three frames of reference previously mentioned(4,Sec. II).

With respect to the inertial frame of the observer, the traditional observer/target frames are all that are needed to describe phenomena. But, when resolving expressions that describe universal expansion(1,Sec. 3.8), the age of the universe, its diameter(1,Eq. 87) and more complex phenomena such as the Cosmic Microwave Background(1,Sec. 3.15), we find that the frame of the universe as a system of reference becomes important. We will consider Hubble's constant(1,Sec. 3.8) as just one example, a measure of some km s^{-1} Mpc^{-1}. Notably, the reference distance, the megaparsec, is somewhat arbitrary. Moreover, as an arbitrary value, it is unconstrained with respect to the system we are describing (the universe). Lacking a fixed physical relation to the universe mitigates our ability to recognize important invariant relationships between expansion and the universe.

With MQ, the universe is recognized as the third frame of reference. The properties of the universe are each expressed in the same nomenclature - the three measures(4,Eqs. 67-79) - as are used to describe local phenomena. And, it is as such, that the rate of expansion defined with respect to the universe as opposed to the megaparsec is $H_U=2\vartheta_{si}$(1,Eq. 81).

Several discoveries are immediately apparent. For one, we discover that the rate of expansion is invariant. We also find that the rate of expansion correlates the three measures: $l_f m_f=2\vartheta_{si} t_f$(4,Eq. 73).

Inputs

There are no inputs needed to resolve this expression.

Terms

- l_f, m_f and t_f are effectively Planck's Units for length, mass and time, but not precisely the same. In MQ we recognize them as the fundamental units.
- ϑ_{si}, is 3.26239 radians or kg m/s (momentum) or no units at all a function of the chosen frame of reference. This is a new constant to modern theory and exists in nearly every equation of the model. It may be measured macroscopically given specific Bell states necessary for quantum entanglement of X-rays such as those carried out by Shwartz and Harris.
- Q_L is the fractional portion of a count of l_f when engaging in a more precise calculation.
- n_{Tu} is a count of t_f equal to the age of the universe.
- n_{Lu} is a count of l_f equal to the diameter of the universe.
- n_{Lc} is the change in position of light as a count of l_f as measured in the local frame of reference.
- n_{Lm} is the change in position of the target as a count of l_f as measured in the local frame of reference.
- n_T is a count of t_f representing the time elapsed between two events.
- n_L is a count of l_f typically used when describing distance with respect to an observer.
- G is Newton's gravitational constant, 6.67408 10^{-11} m^3 kg^{-1} s^{-2}.
- c is the speed of light which may also be written as $c=l_f/t_f$=299,792,458 m/s.
- $\hbar$ is Planck's reduced constant adjusted for the Informativity differential as a function of distance to target. In later research, the symbol $\hbar_f$ is used to indicate that the Informativity differential has been included in the expression.

46 MQ Discoveries

Physical Constants

- Fundamental Measures
- Fundamental Constant
- Physical Significance Measure
- Bounds to Measure
- Upper Bound to Mass Density
- What Defines Measure
- **Frames of Reference**
- Gravitational Constant
- Newton & Planck Constants
- Hubble's Constant
- Fine Structure Constant
- Electric Constant
- Magnetic Constant
- Coulomb's Constant
- Elementary Charge
- Planck's Constant
- Physical Constants—Extended

Classical & Quantum

- Quantum Gravity
- Angular Measure & Momentum
- Quantum Entangled X-Rays
- Blackbody Demarcation
- Energy: Einstein/Planck
- The Fundamental Expression
- Informativity Differential
- Measure Distortion w/ Motion
- Measure Distortion w/ Gravity
- Equivalence Motion & Gravity
- Particles vs. Waves
- Properties of the Atom
- Singularities
- Spacetime Curvature
- Dimensions in Space
- Kinetic Energy
- Quantization Ratios
- Unification Gravity/EM

Cosmology

- Diameter & Age of the Universe
- Quantum Inflation & the CMB
- Dilation of the CMB Age
- Observable Universe is Dilated
- Mass Accretion in the Universe
- CMB Power Spectrum
- Mass Distributions w/o Λ CDM
- Dark Energy
- Galactic Rotation (dark matter)
- Effective Mass of a Galaxy
- Newtonian Crossover

The MQ Collaboration for Foundational Research

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We find that ϑ_{si} is the only constant necessary to resolve each of the mass/energy distributions presently described by ΛCDM(1,Eqs. 109, 110, 113 & 115). And we find that ϑ_{si} describes gravitational curvature(1,Tbl. 2) with quantum precision throughout the entire measurement domain. That is to say, physical support for ϑ_{si} covers nearly every discipline from gravity(4,Eqs. 29-33), optics(4,Eq. 56, Tbl II), quantum mechanics(4,Tbls. II & III) and cosmology(1,Sec. 3.8) with six sigma significance.

Over the last century, the third frame has most often been incorporated into expressions with respect to the speed of light. That is, c represents an invariant descriptor of the universe and for the most part we find c in many expressions describing phenomena. In MQ form(3,Sec. 2.3), we would call this an upper bound relation(2,Sec. 3.9), specifically describing length frequency(3,Eqs. 15-17), the upper count bound of fundamental units of length with respect to a fundamental unit of time l_f/t_f. Equally important is mass frequency, a description of the upper bound m_f/t_f and the following relation l_f/m_f which we have not assigned a name. Each are important bounds, for example mass frequency is essential to resolving an expression for the orbital velocity of stars in a galaxy(3,Eqs. 66) (i.e. the dark matter phenomenon).

Moreover, there are specific relations between the universal frame and the fundamental measures(4,Eqs. 67-79) ... namely ... fundamental mass. We may, for instance resolve fundamental mass m_f in terms of a count of length units representing the radius of the universe divided by a count of time units representing the age of the universe(1,Eq. 76). We may, if desired change the scale to SI form in terms of light-years and years, or billions of each. Expressions exist for each of these relations in the section that discusses Hubble's constant(1,Sec. 3.8) and the Age and Diameter of the Universe(1,Sec. 3.9).

For our present purpose, we note that these expressions are defined with respect to the universe. In MQ form, the universe is considered a system and allows for expressions that describe properties of the universe with respect to an observer outside or inside the universe. For instance, those expressions that describe the universe are the same as those that describe a fundamental unit of mass m_f(1,Eq. 76). Only, expressions describing fundamental mass are from the perspective of an external frame and expressions describing the universe are with respect to an internal frame. Correlating the two and resolving their physical significance is a field of research open for further publication.

Finally, we will address the expansion parameter $2\vartheta_{si}$ briefly and its role with respect to the third frame. We may, for instance reformulate the *fundamental expression*(4,Eq. 73) into a form known as a unity expression with respect to motion(2,Eq. 102). In this form, we can visualize the expansion of the universe as a function of motion n_{Lm}^2 with respect to the speed of light n_{Lc}^2. You may also recognize this as the speed parameter v^2/c^2 common in many relativity expressions.

You will notice that the expansion parameter(1,Sec. 3.8) in this context appears to be nondimensionalized, carries no units. Up to this point ϑ_{si} has carried the units of momentum(2,Pg. 25). That would be an appropriate dimension with respect to most expressions describing a local phenomenon as viewed with respect to an observer in the universe. We call such expressions self-referencing(2,Sec. 3.4).

But, for phenomena that are defined with respect to the universe (self-defining) as is the case in the above unity expression, ϑ_{si} has no units. That is to say, it is dimensionless. Recognition of this trait is important in MQ and central to the concepts of references. Specifically, the self-referencing expressions we use to describe nearly all interactions between an observer and a target are dimensional. The observer/target frame of reference as demonstrated by Heisenberg's uncertainty principle(4,Eqs. 6-10) is what sets the foundation to discreteness in measure(4,Eqs. 67-79). In contrast, the universe has no external reference and as such phenomena that are properties of the universe are non-discrete (i.e. expansion $H_U=2\vartheta_{si}$).

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Peer Review

6 *Measurement Quantization Describes the Physical Constants*

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2 *Quantum Model of Gravity Unifies Relativistic Effects, Describes Inflation/Expansion Transition, Matches CMB Data*

3 *Measurement Quantization Accounts for Galactic Rotational Velocities and Obviates Dark Matter*

4 *Physically Significant Units of Measure*

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