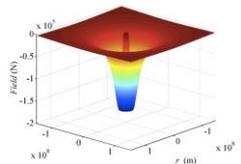


On a Heuristic Point of View Concerning the Mass of the Higgs Boson

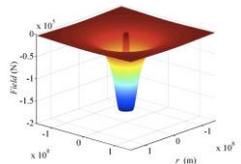
Réjean Plamondon

**Département de Génie Électrique
École Polytechnique de Montréal**



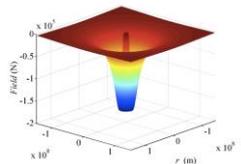
Research Hypothesis

The basic hypothesis behind this talk is that if all the masses in the Universe have a common origin, through the interaction with a Higgs field, and if there is a way to bridge the gap between General Relativity and Quantum Mechanics, there must be some indirect manifestations of this phenomenon at different scales and may be some relationships could be pointed out between the different mass values as measured in this unifying representation.



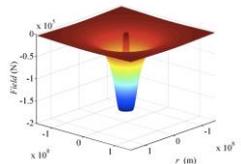
Topics

- Linking General Relativity and Quantum Mechanics
- Mass Definition and Measurement
- Predictions
- Conclusion



Topics

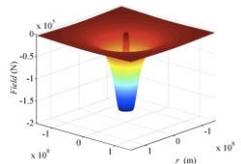
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Interdependence principle

Spacetime curvature (S) and matter-energy density (E) are two inextricable information spaces defining the **physically observable probabilistic universe (U)**; they must be mutually exploited to describe any subset U_i of this universe. The probability of observing a subset (U_i) is:

$$P(U_i) = P(S_i, E_i) < 1$$

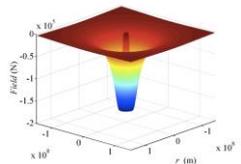


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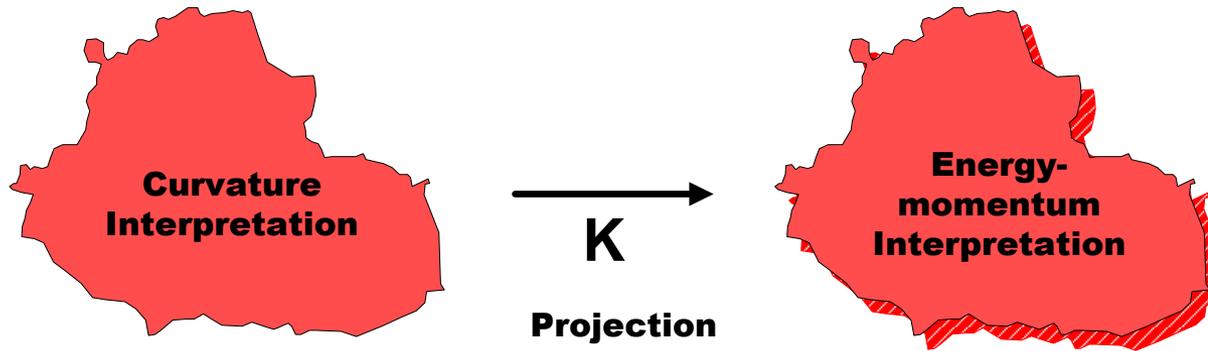
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A rephrasing of the Mach Principle

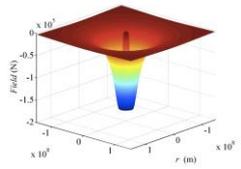


In terms of Bayes' law...

JOINT PROBABILITIES

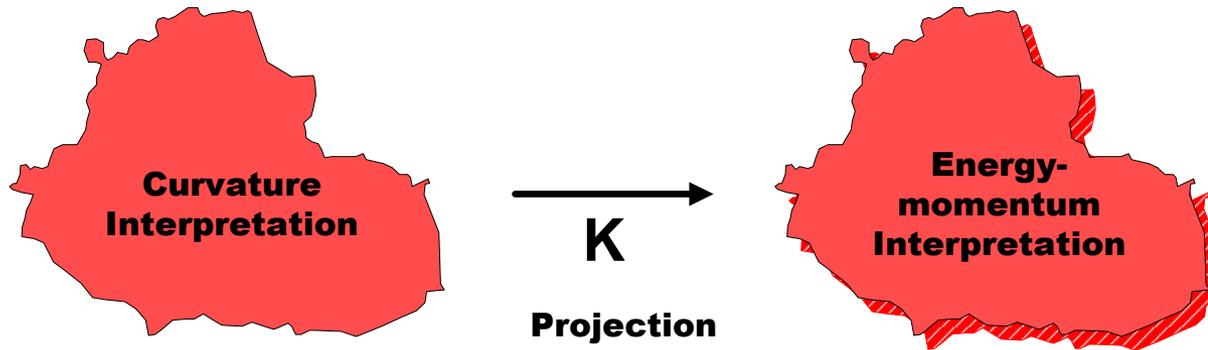


$$P(U_i) = P(S_i, E_i) = P(S_i/E_i)P(E_i) = P(E_i/S_i)P(S_i)$$



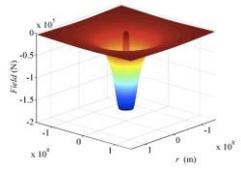
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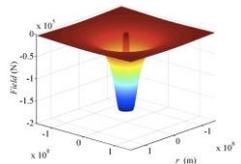
$$P(U_i) = P(S_i, E_i) = P(S_i / E_i) P(E_i) = P(E_i / S_i) P(S_i)$$

$$G = K T \times f(E_i / S_i)$$



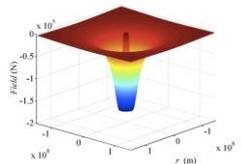
Building a star from scratch

- Adding numerous identical particles ($N \rightarrow \infty$), each one with its own wave function, density function and associated space-time, as seen from a locally flat tangent space.



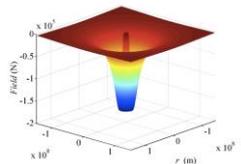
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- Making the convolution of their corresponding density functions.



Building a star from scratch

- Adding numerous identical particles ($N \rightarrow \infty$), each one with its own wave function, density function and associated space-time, as seen from a locally flat tangent space.
- Making the convolution of their corresponding density functions.
- The **central limit theorem** predicts that the ideal form of the global probability density will be a Gaussian multivariate function.



Emergence of the probability density

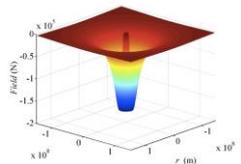
$$f(\bar{r}) = \frac{1}{4\pi^2\sigma^4} \exp\left(-\frac{\bar{r}^2}{2\sigma^2}\right) \Rightarrow \text{External 4D Flat Space}$$

$\sigma \Rightarrow$ emergent parameter

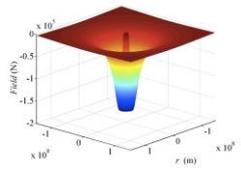
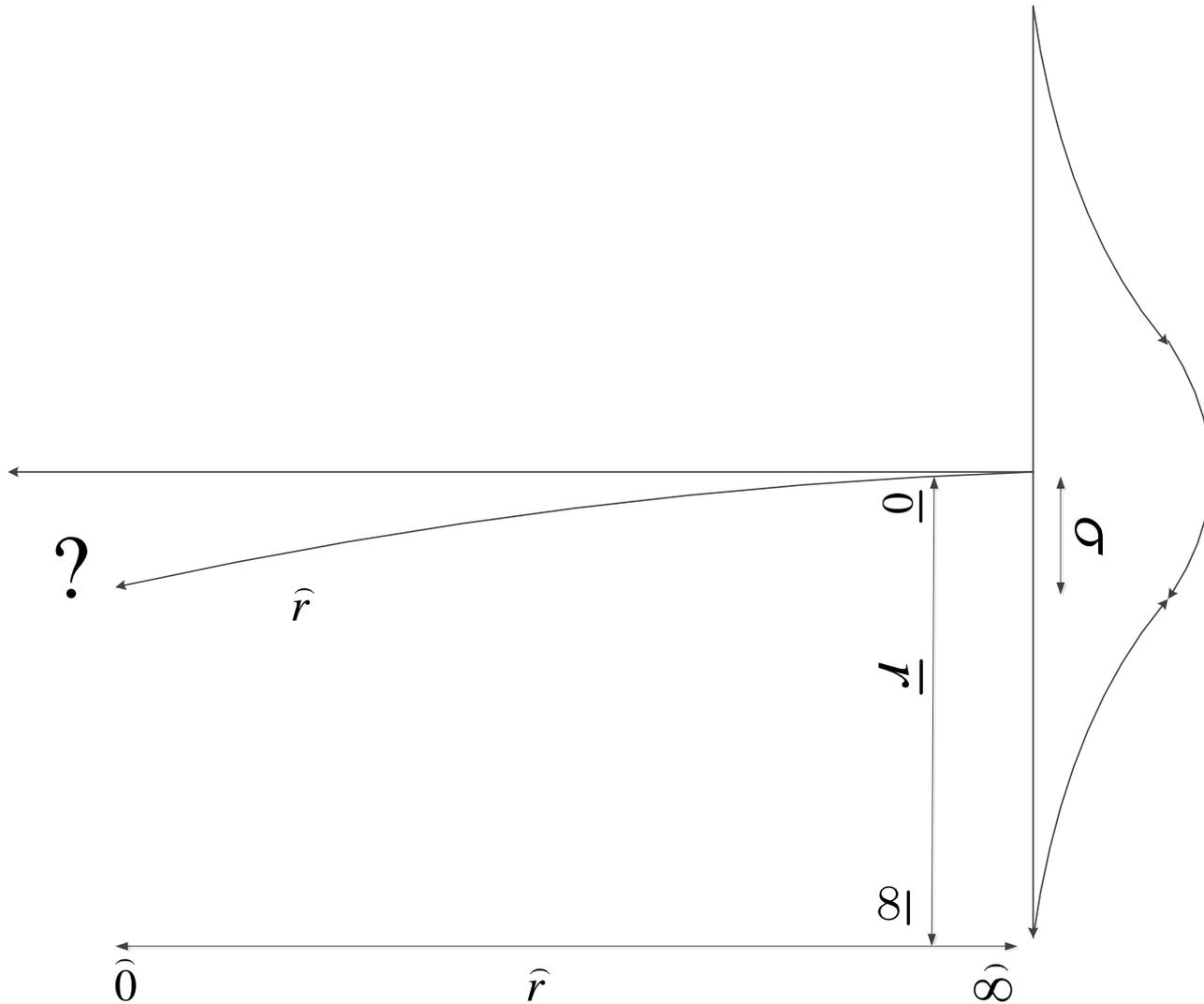
$\sigma \Rightarrow$ intrinsic proper length of the system

$\sigma \Rightarrow$ a range parameter, an anchor point

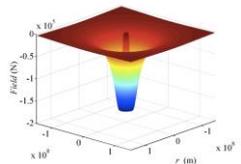
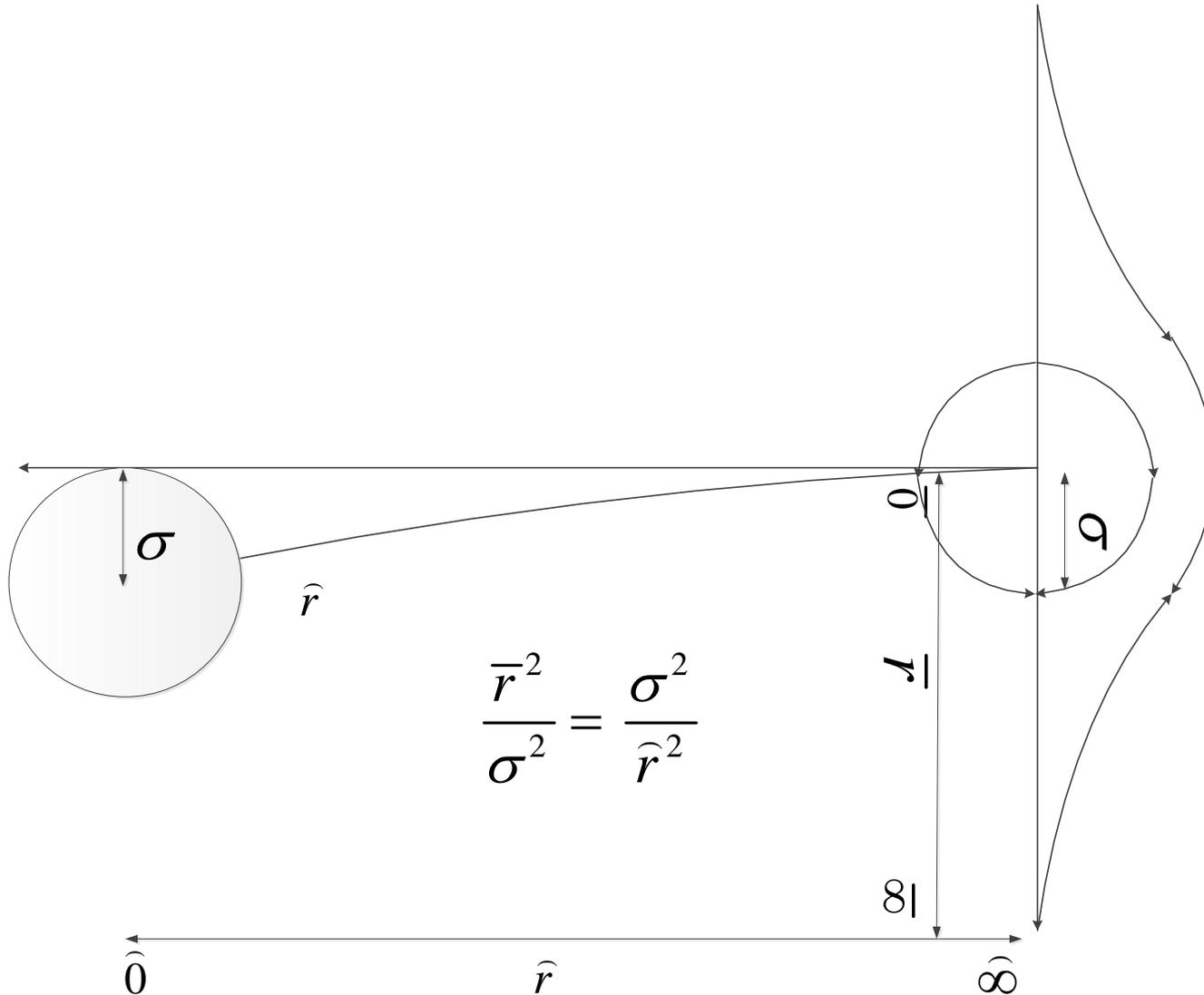
$f(\tilde{r}) \Rightarrow$ Internal curved space?



Curved vs flat space representations



Defining reference 2-spheres

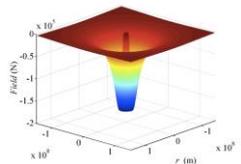


Invariance of the proper length

$$\frac{d\bar{r}}{\bar{r}} = -\frac{d\tilde{r}}{\tilde{r}}$$

$$\text{Mapping} \Rightarrow \frac{\bar{r}^2}{\sigma^2} = \frac{\sigma^2}{\hat{r}^2}$$

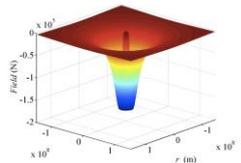
$$f(E_i / S_i) = \frac{1}{4\pi^2 \sigma^2 \hat{r}^2} \exp\left(-\frac{\sigma^2}{2\hat{r}^2}\right) \Rightarrow \text{Internal Curved Space}$$



Estimating the momentum- energy tensor

$$T_{00} \bar{r}=\sigma = T_{00} \hat{r}=\sigma = \frac{M_{tot} c^2}{4\pi\sigma^2}$$

$$T_{00} \hat{r} = \frac{M_{tot} c^2}{4\pi\sigma^2} \left(\frac{\sigma}{\hat{r}} \right)^3 = \frac{M_{tot} \sigma c^2}{4\pi\hat{r}^3}$$

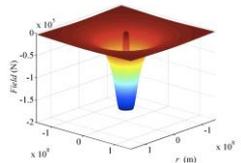


Emergence of Newton's law of gravitation

$$R_{00} \cong \frac{1}{c^2} \nabla^2 \Phi = \frac{1}{2} K T_{00} f(E_i / S_i)$$

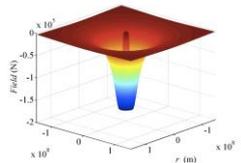
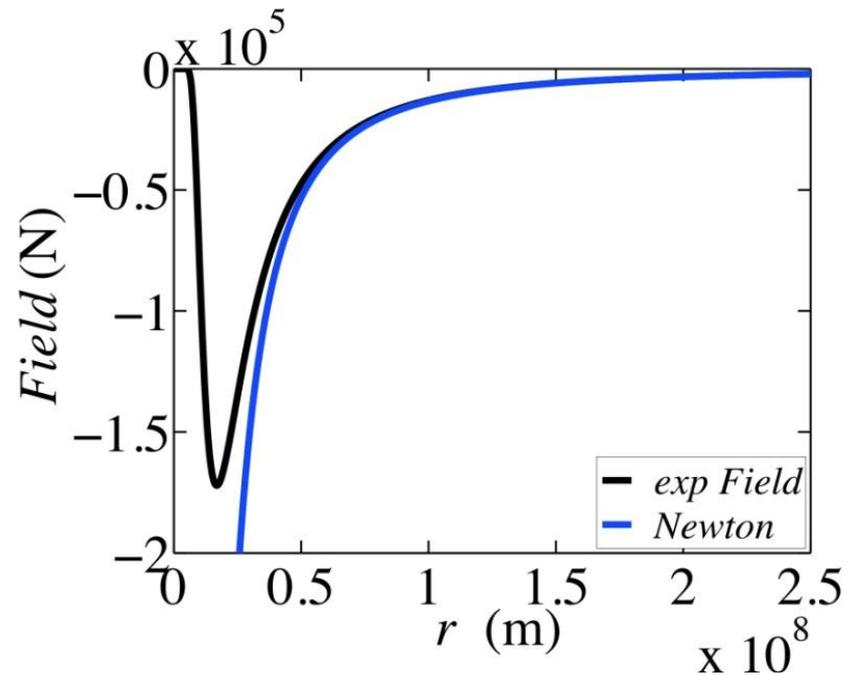
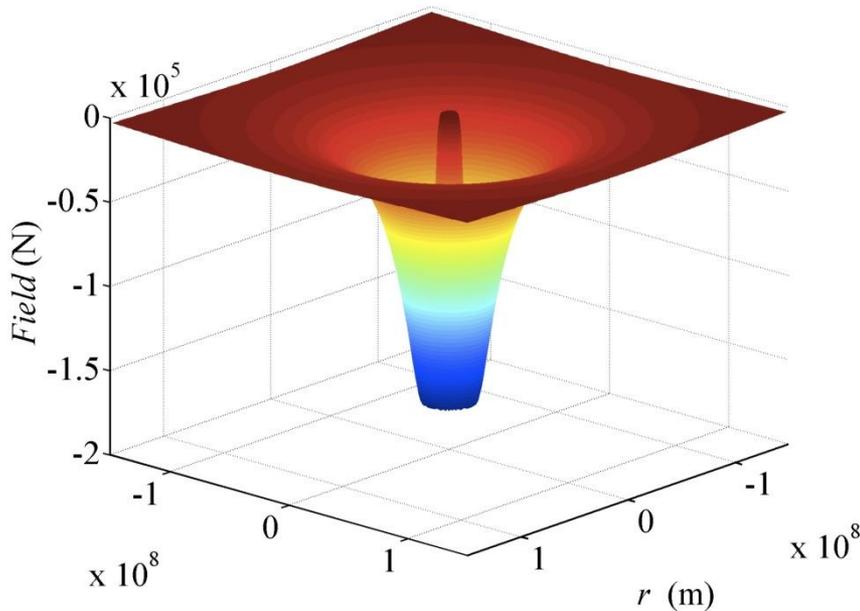
$$\nabla^2 \Phi = \frac{2 K M c^4 \sigma^2}{4 \pi \sigma^3 r^5} \exp\left(-\frac{\sigma^2}{2 r^2}\right)$$

where from now on, the curved hat over the coordinate r is omitted.



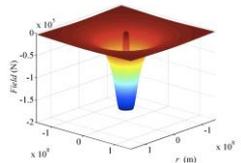
Emergence of a **Modified** Newton's law of gravitation

$$g(r) = -\left| \vec{\nabla} \Phi \right| r = -\frac{GM}{r^2} \exp\left(-\frac{\sigma^2}{2r^2}\right)$$

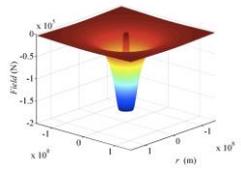
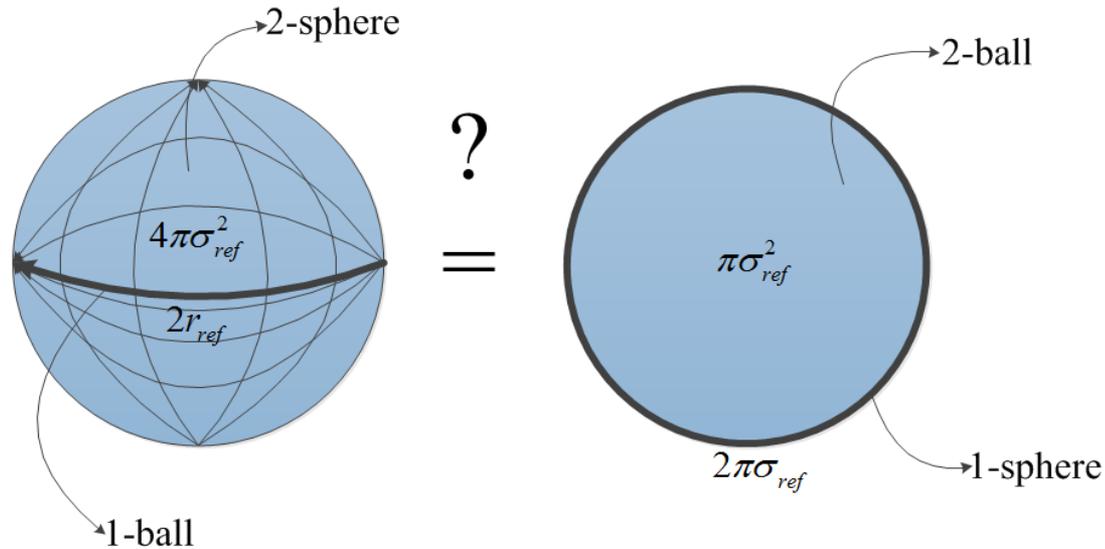


Topics

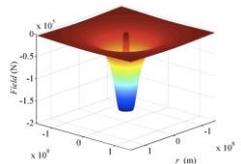
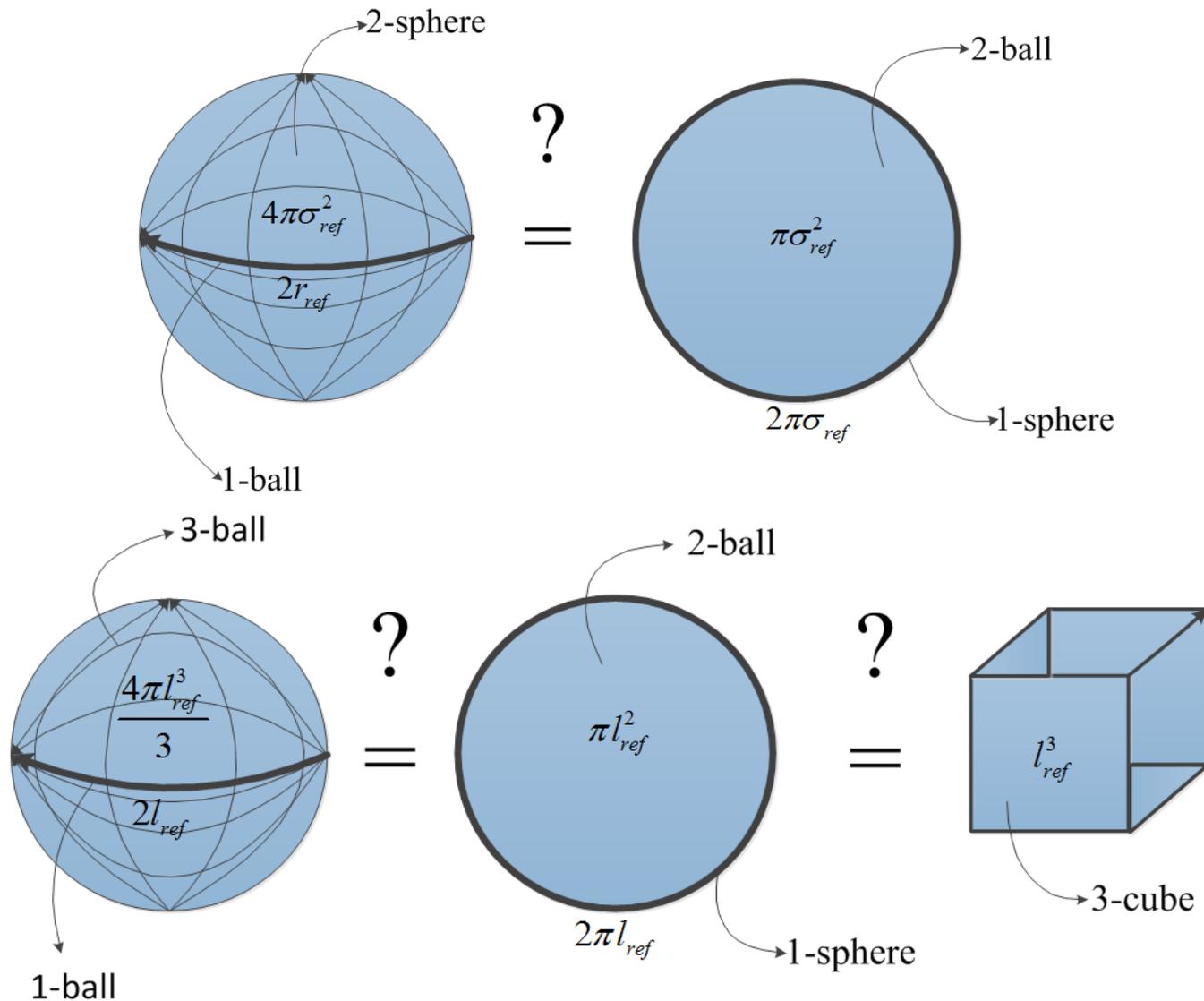
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Challenges: keep coherent representations



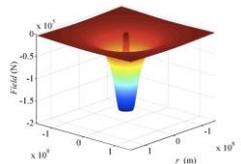
Challenges: keep coherent representations



Once upon a time...

An observer living on a planet P orbiting a star, S , has defined a reference length unit l_{ref} and has then used $(y l_{ref})^3$ to define a reference volume in which he has poured into an amount x of a substance s_1 , to establish **a macroscopic unit of inertial mass**

u_{im} .



Macroscopic vs Microscopic

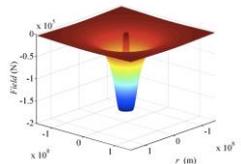
Moreover, on the same reference density basis, he has defined **a microscopic unit of mass u** from u_{im} :

$$u_{im} = wN_0 u$$

where w is a weighting factor that takes into account the plausible ratio between the arbitrary units u_{im} and u

and where N_0 is a numerical constant such that the specific mass of any substance s_x can be expressed in the macroscopic or microscopic scales using the same numerical value Z_x :

$$m_{s_x(u_{im})} = Z_x u_{im} = Z_x w N_0 u \Leftrightarrow m_{s_x(u)} = Z_x u$$



Macroscopic vs Microscopic

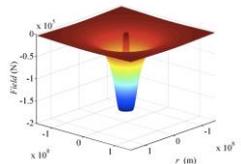
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Units of volumetric mass density

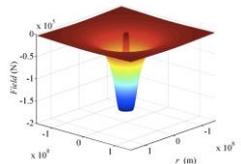
This calibration process also lead him to define a **local volumetric mass reference density** ρ_{ref} :

$$\rho_{ref} = \frac{u_{im}}{y^3 l_{ref}^3}$$

which de facto defined the **global unit of volumetric mass reference density**:

$$u_{\rho_{ref}} = \frac{u_{im}}{l_{ref}^3}$$

used in the present theory.

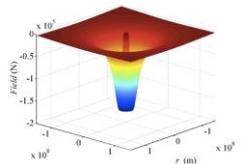


A first correction

Since this theory refers to volumes defined in (l_{ref}^3) , to find a mass m_1 in a system based on $(y^3 l_{ref}^3)$ will require respecting the following constraint:

$$\frac{m_1|_{l_{ref}^3}}{4\pi l_{ref}^2} \frac{1}{\rho_{ref}} = \frac{m_1|_{l_{ref}^3}}{4\pi l_{ref}^2} \frac{l_{ref}^3}{u_{im}} = \frac{m_1|_{y^3 l_{ref}^3}}{4\pi y^2 l_{ref}^2} \frac{1}{\rho_{ref}} = \frac{m_1|_{y^3 l_{ref}^3}}{4\pi y^2 l_{ref}^2} \frac{y^3 l_{ref}^3}{u_{im}}$$

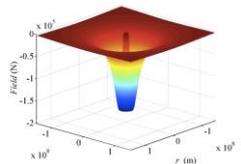
$$m_1|_{l_{ref}^3} = \frac{m_1|_{y^3 l_{ref}^3}}{y}$$



Global unit of volumetric mass density

The global unit of volumetric mass density can be recovered from any substance s_x of inertial mass expressed in u_{im} and volume expressed in l_{ref}^3 using:

$$u_{\rho_{ref}} = \frac{m_{s_x}(u_{im})}{V_{s_x}(l_{ref}^3)} \quad \text{with} \quad |m_{s_x}| = |V_{s_x}| \quad \text{numerically}$$

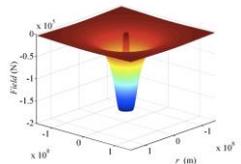


Mass relationships

In the context of the definition of the volumetric mass density unit $u_{\rho_{ref}}$

which is substance independent and based on any unitary inertial mass to volume ratio, various relationships among inertial masses measured in the star system can be pointed out:

$$u_{\rho_{ref}} = \text{constant} \Rightarrow m_{i1} = \frac{m_{i2}m_{i3}}{m_{i4}} \text{ if } \frac{V_1V_4}{V_2V_3} = 1$$



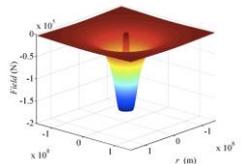
A Modified Gravitational Field

According to a recent Bayesian model, the observer's planet could be seen, in a curved spacetime representation, under low speed, weak field conditions, as attracted by a modified gravitation field:

$$\vec{g}_M = \frac{GM_{gS}}{r_{PS}^2} \exp\left(-\frac{\sigma_S^2}{2r_{PS}^2}\right) \vec{u}_r$$

where σ_S

is a range parameter representing the proper length of the star, that is the intrinsic scale of the star system.

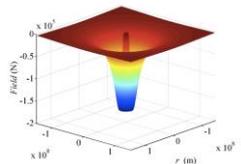


A mandatory correction

In this context, the interaction between a test mass m_1 and a source mass m_2 in both N and M representations will respect the following constraint:

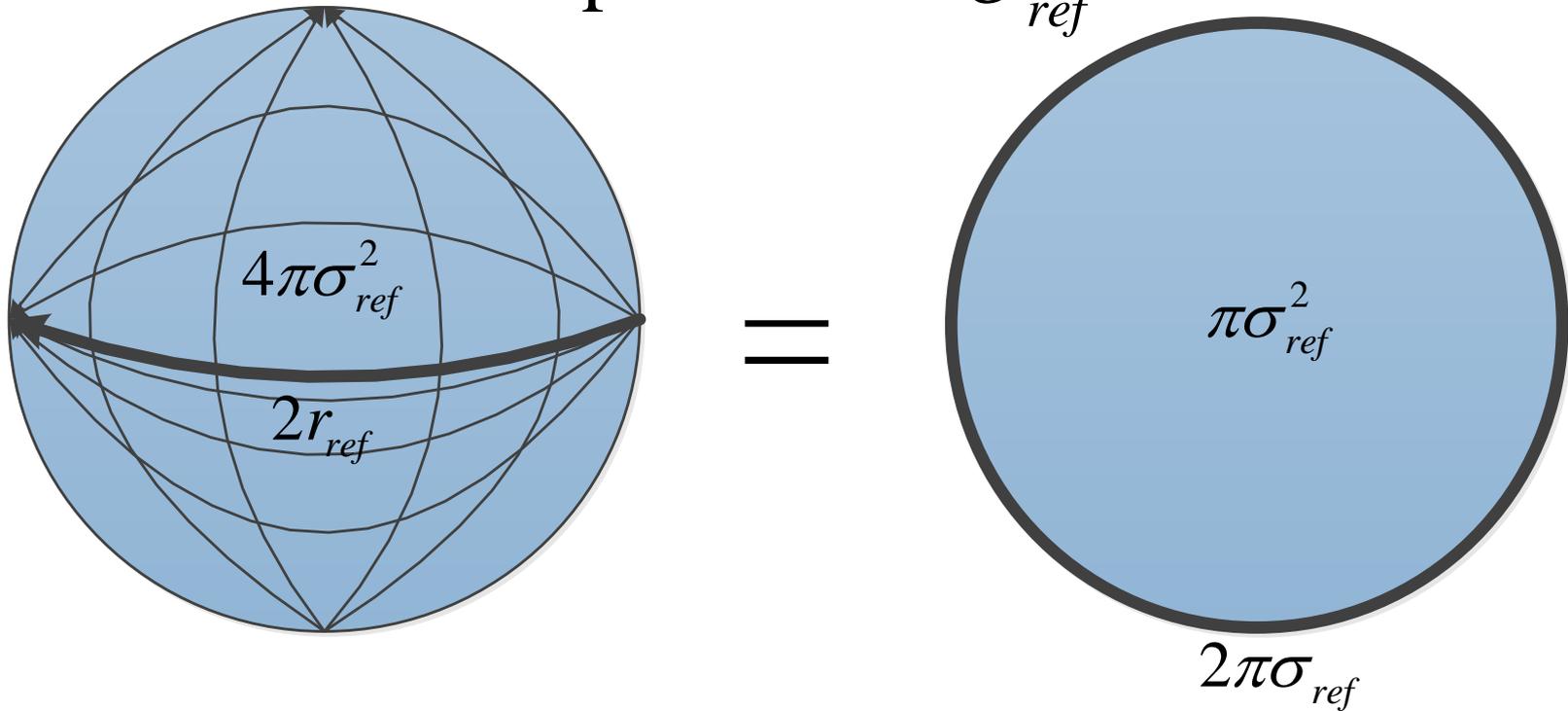
$$m_{1gN}m_{2gN} = m_{1gM} \Big|_{\sigma_1=0} m_{2gM} \Big|_{\sigma_2=0}$$

$$m_{1iN}m_{2iN} = m_{1gM} \Big|_{\sigma_1=0} \exp\left(-\frac{\sigma_1^2}{2r^2}\right) m_{2gM} \Big|_{\sigma_2=0} \exp\left(-\frac{\sigma_2^2}{2r^2}\right)$$

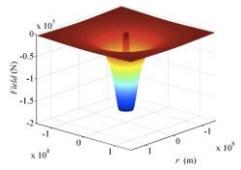


Heuristics

Define all inertial mass on the same relative scale,
independent of σ_{ref}



$$\frac{2r_{ref}}{4\pi\sigma_{ref}^2} = \frac{2\pi\sigma_{ref}}{\pi\sigma_{ref}^2} \Rightarrow r_{ref} = 4\pi\sigma_{ref}$$



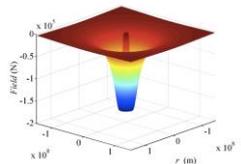
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$$m_{1gN} m_{2gN} = m_{1gM} \Big|_{\sigma_1=0} m_{2gM} \Big|_{\sigma_2=0}$$

$$m_{1iN} m_{2iN} = m_{1gM} \Big|_{\sigma_1=0} \exp\left(-\frac{1}{32\pi^2}\right) m_{2gM} \Big|_{\sigma_2=0} \exp\left(-\frac{1}{32\pi^2}\right)$$

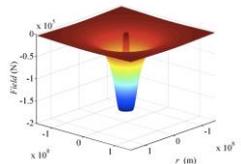
$$m_{2iN} = \frac{m_{1gN}}{m_{1iN}} m_{2gN} \exp\left(-\frac{1}{16\pi^2}\right)$$



Summary

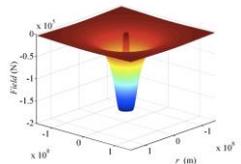
$$m_1 \Big|_{l_{ref}^3} = \frac{m_1 \Big|_{y^3 l_{ref}^3}}{y}$$

$$m_{2iN} = m_{2gN} \exp\left(-\frac{1}{16\pi^2}\right)$$



Topics

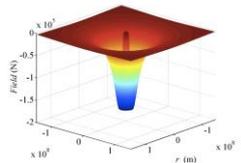
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Basic premise

The whole M representation relies on a basic premise: **the preservation of the volumetric mass density unit $u_{\rho_{ref}}$** , throughout the various spacetime projections that are necessary to model and understand a physical phenomenon.

$$u_{\rho_{ref}} = \text{constant} \Rightarrow m_{i1} = \frac{m_{i2}m_{i3}}{m_{i4}} \text{ if } \frac{V_1V_4}{V_2V_3} = 1$$



P1: minimal reference test mass

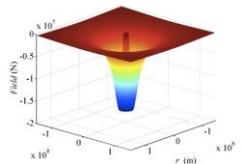
Fixing:

$$m_{i1} = m_{iref \min} \left| \frac{m_{iref \min} |y^3 l_{ref}^3}{y} \right|$$

$$m_{i2} = u_{im}$$

$$m_{i3} = m_{is1}$$

$$m_{i4} = M_{gS} \exp\left(-1/16\pi^2\right)$$



P1: minimal reference test mass

Fixing:

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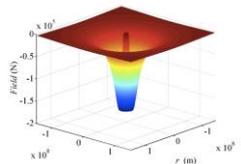
$$m_{i2} = u_{im}$$

$$m_{i3} = m_{is1}$$

$$m_{i4} = M_{gS} \exp\left(-1/16\pi^2\right)$$

one gets:

$$m_{iref \min} \Big|_{y^3 l_{ref}^3} = \frac{y u_{im} m_{is1}}{M_{gS} \exp\left(-\frac{1}{16\pi^2}\right)}$$



To fix the ideas

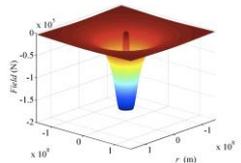
$$M_P = M_{Earth} = 5.98 \times 10^{24} \text{ kg}$$

$$M_{gS} = M_{Sun} = 1.99 \times 10^{30} \text{ kg}$$

$$m_{is_1} = m_{H_2O} = 18.01528 \text{ kg}$$

$$u_{im} = 1\text{kg} \Rightarrow w = 1\text{kg}/1\text{g} = 1000$$

$$y = 1\text{dm} / 1\text{m} = 0.1$$



To fix the ideas

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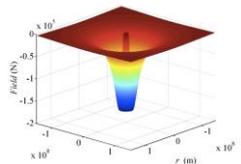
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$$u_{im} = 1\text{kg} \Rightarrow w = 1\text{kg}/1\text{g} = 1000$$

$$y = 1\text{dm} / 1\text{m} = 0.1$$

$$m_{iref \min} \Big|_{y^3 l_{ref}^3} = 9.11(0562450) \times 10^{-31} \text{ kg} \cong m_{electron}$$



P2: maximal minimal **gravitational** reference test mass

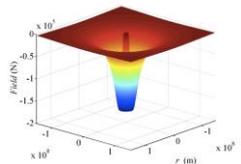
Fixing:

$$m_{i1} = m_{gref} \max \min \left| y^3 l_{ref}^3 \right|$$

$$m_{i2} = u_{mi}$$

$$m_{i3} = m_{iref} \min \left| l_{ref}^3 \right|$$

$$m_{i4} = M_{gP}$$



P2: maximal minimal **gravitational** reference test mass

Fixing:

$$m_{i1} = m_{gref \max \min} \Big|_{y^3 l_{ref}^3}$$

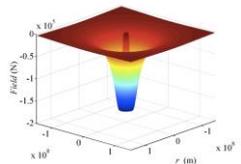
$$m_{i2} = u_{mi}$$

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$$m_{i4} = M_{gP}$$

one gets:

$$m_{gref \max \min} \Big|_{y^3 l_{ref}^3} = \frac{y^2 u_{im}^2}{M_{gP}}$$



P2: maximal minimal **gravitational** reference test mass

Fixing:

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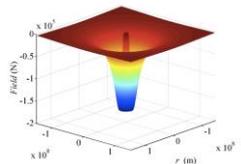
$$m_{i3} = m_{iref \min} \Big|_{l_{ref}^3}$$

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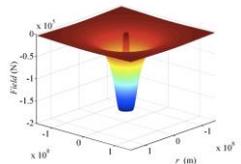
$$m_{gref \max \min} \Big|_{y^3 l_{ref}^3} = \frac{y^2 u_{im}^2}{M_{gP}}$$

$$m_{gref \max \min} \Big|_{y^3 l_{ref}^3} = 1.67(2240803) \times 10^{-27} \text{ kg} \cong m_{proton}$$



P3: maximal minimal **inertial** reference source mass

$$\begin{aligned} m_{iref \max \min M} &= m_{gref \max \min M} \exp\left(-\frac{1}{16\pi^2}\right) \\ &= \frac{y^2 u_{im}^2}{M_{gP}} \exp\left(-\frac{1}{16\pi^2}\right) \end{aligned}$$

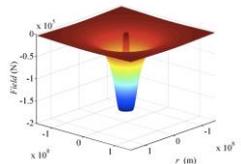


P3: maximal minimal **inertial** reference source mass

$$m_{iref \max \min M} = m_{gref \max \min M} \exp\left(-\frac{1}{16\pi^2}\right)$$

$$= \frac{y^2 u_{im}^2}{M_{gP}} \exp\left(-\frac{1}{16\pi^2}\right)$$

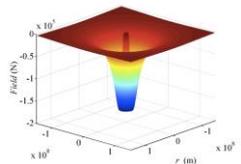
$$m_{iref \max \min} \Big|_{y^3 l_{ref}^3} = 1.66(1684673) \times 10^{-27} \text{ kg} \cong u$$



P4: invariant mass scale factor

Finally, since:

$$\mathbf{u} = \frac{u_{im}}{wN_0}$$



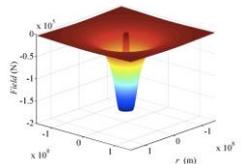
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This leads to:

$$N_0 = \frac{M_{gP}}{wy^2 u_{im}} \exp\left(\frac{1}{16\pi^2}\right)$$



P4: invariant mass scale factor

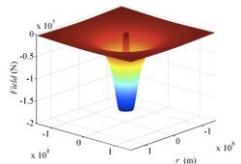
Finally, since:

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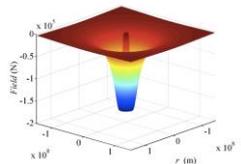
$$N_0 = \frac{M_{gP}}{wy^2 u_{im}} \exp\left(\frac{1}{16\pi^2}\right)$$

$$N_0 = 6.01(7988949) \times 10^{23} \cong N_A$$



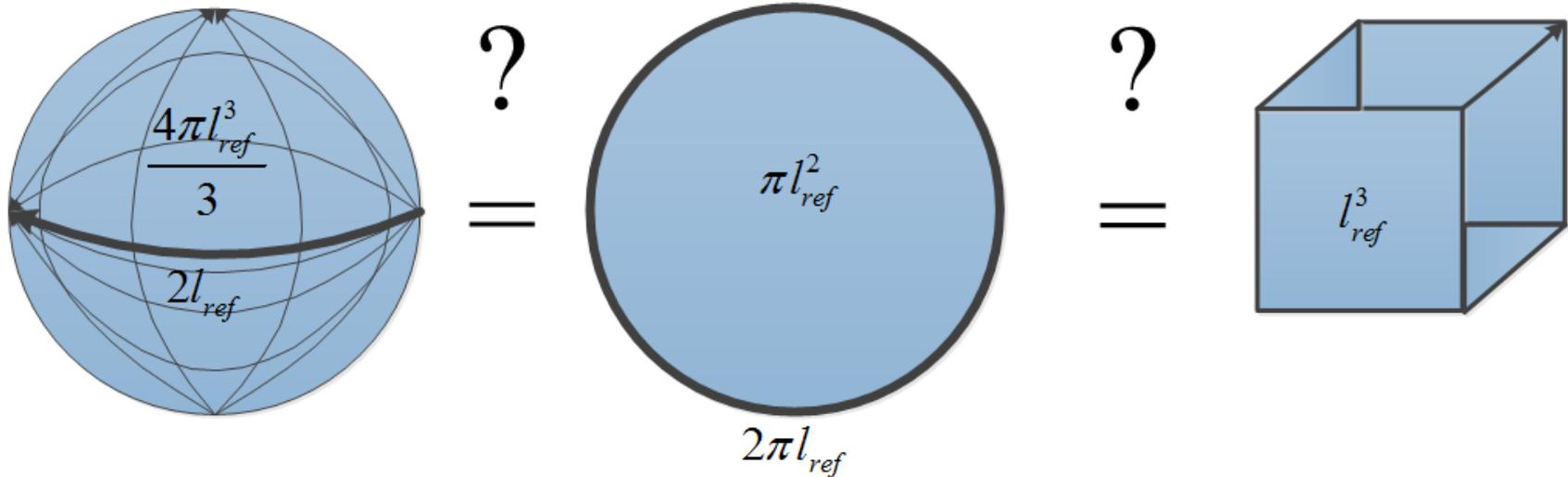
The local reference mass?

Finally, the observer can presume the existence of a local mass reference $m_{iref.loc}$ that can bring any mass measurements with respect to his own planet data considered as a source mass, once the proper projections between the 1D kinematic observation space and 3D mass densities, all expressed in u_{im} unit, are taken into account:

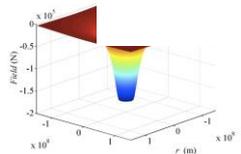


Heuristics

Maintaining a correspondence between the relative linear and volumic densities



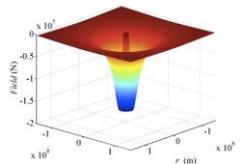
$$\frac{m_{iref.loc}}{2l_{ref}} \times \frac{2\pi l_{ref}}{u_{im}} = \frac{u_{im}}{l_{ref}^3} \times \frac{4\pi l_{ref}^3}{3M_{gp} \exp\left(-\frac{1}{16\pi^2}\right)}$$



P5: local reference mass

In other words, the local mass reference can be defined as:

$$m_{iref.loc} = \frac{4}{3} \frac{u_{im}^2}{M_{gP} \exp\left(-\frac{1}{16\pi^2}\right)}$$

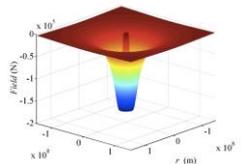


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$$m_{iref.loc} = \frac{4}{3} \frac{u_{im}^2}{M_{gP} \exp\left(-\frac{1}{16\pi^2}\right)}$$

$$m_{iref.loc} = 2.24(381866) \times 10^{-25} \text{ kg}$$



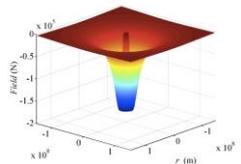
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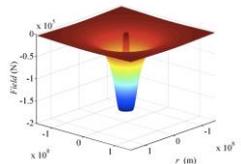
$$m_{iref.loc} = 2.24(381866) \times 10^{-25} \text{ kg}$$

$$m_{iref.loc} = (125.869 \text{ GeV}) \cong m_{Higgs}$$



Concluding Remark

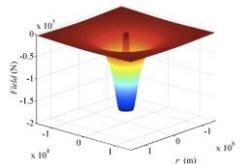
Using the modified gravitational model, derived from a potential link between General Relativity and Quantum Mechanics, and taking into account the various projections that are required to perform mass and density measurements respecting the star proper length, as well as considering the physical environment and the specific context in which these estimates are made, **interesting numerical patterns** among some mass references can be pointed out, which is in line with the hypothesis of mass common origin.



Concluding Remark

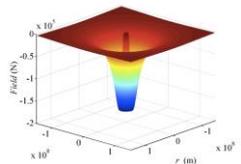
Once instantiated with the Sun-Earth data, these predictions seem to be quite consistent with the numerical values measured on Earth. Among other things, the mass of the Higgs boson appears as a condition that maintains the relative linear and volumic densities among the various mass definitions:

$$m_{Higgs} = \frac{4}{3} \frac{(1kg)^2}{M_{Earth} \exp(-1/16\pi^2)} = \frac{4}{3} \frac{m_{proton}}{y^2 \exp(-1/16\pi^2)}$$



Concluding Remark

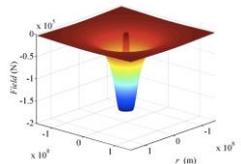
The overall process provides a practical criterion to evaluate the consistency of a system of mass units in a two body system, made up of a planet P and a star \underline{S} :



Concluding Remark

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$$\left[m_{gref \max \min} \left| y^3 l_{ref}^3 \right. M_{gP} \right]^{1/2} = \frac{m_{iref \min} \left| y^3 l_{ref}^3 \right. M_s}{m_{s1}} \exp\left(-\frac{1}{16\pi^2}\right) = yu_{im}$$

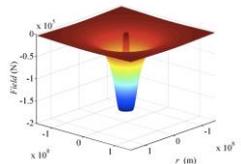


Concluding Remark

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which maintains the coherence between the macroscopic and microscopic description of the system.



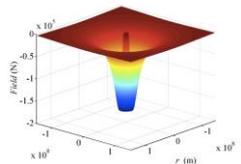
To investigate further...

A brief survey of the whole approach regarding emerging patterns:

Pattern Recognition 47 (2014) 929–944

“Strokes against stroke—strokes for strides”

Réjean Plamondon, Christian O'Reilly, and
Claudéric Ouellet-Plamondon.



To go deeper...

Réjean Plamondon

PATTERNS IN PHYSICS

*Toward a
Unifying Theory*

Réjean Plamondon is a professor in the Electrical Engineering Department at École Polytechnique de Montréal. His main research interests deal with pattern recognition, human motor control, neurocybernetics, biometry and theoretical physics. As a full member of the Canadian Association of Physicists, the Ordre des Ingénieurs du Québec and the Union Nationale des Écrivains du Québec, Professor Plamondon is an also active member of several international societies. He is a lifetime Fellow of the Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS, 1989), the International Association for Pattern Recognition (IAPR, 1994) and the Institute of Electrical and Electronics Engineers (IEEE, 2000).



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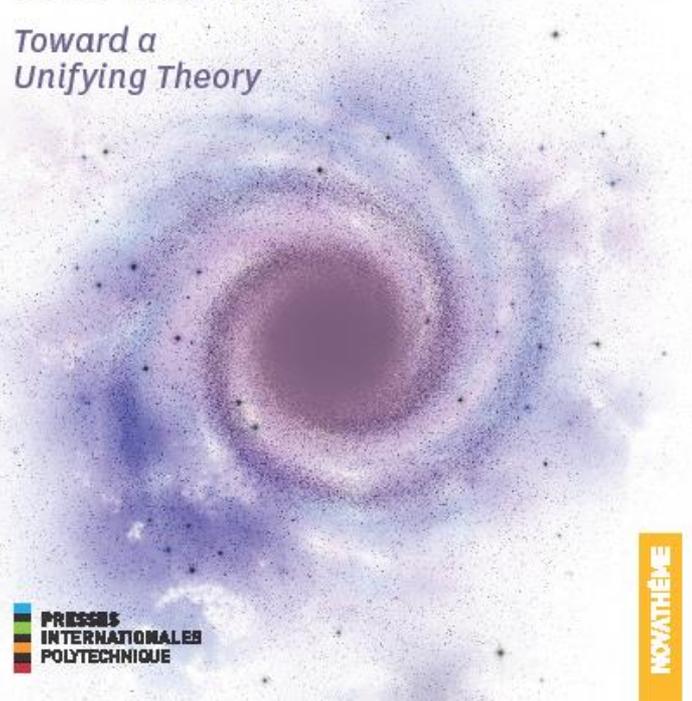
PATTERNS IN PHYSICS

*Toward a
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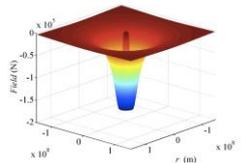
PATTERNS IN PHYSICS
Toward a Unifying Theory

Why are there four basic laws of Nature and where do they come from? Why does any massive body in the universe experience an intrinsic rotation? What is the link between the speed of light and the gravitational, Boltzmann and Planck constants? What are the relationships between electron mass, the Avogadro number, vacuum permittivity, and the masses of the Sun and the Earth? Are dark matter and dark energy necessary to explain the observable Universe? Can the lepton family be reduced to two members? These are just a few of the many questions that this scientific work addresses and to which it provides potential answers.

When we apply various pattern analysis methods to study the Universe, this leads us to considering the physical laws of Nature as emerging blueprints, and the fundamental constants as numerical primitives. Starting from two basic premises, the principles of interdependence and of asymptotic congruence, and using a statistical pattern recognition paradigm based on Bayes' law and the central limit theorem, Einstein's global field equation is generalized to incorporate a probabilistic factor that better reflects the interconnected role of space-time curvature and matter-energy density, with the aim of bridging the gap between quantum mechanics and general relativity. The whole concept predicts the emergence of the elementary interactions and the numerical value of the fundamental constants. To accomplish this, many notions and concepts are revisited, from the origin of the electron charge to the existence of black holes and the sine qua non Big Bang, providing a novel starting point to redirect our long-term quest for the unification of physics.



NOVATHÈME



Réjean Plamondon, ACP 2014, Sudbury.

POLYTECHNIQUE
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On a Heuristic Point of View Concerning the Mass of the Higgs Boson

Réjean Plamondon

Département de Génie Électrique
École Polytechnique de Montréal

Questions?

