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Assuming Photon as Extended Point Particle in the HyperSoft Topological Space and other Hypotheses: Issues and Trend Analysis

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Abstract

Following our preceding article, where we discussed alternative interpretations of the advanced perihelion of Mercury, the present article revisits the 1919 solar eclipse expedition led by Arthur Eddington, which famously provided the first observational confirmation of Einstein's theory of general relativity. We focus on the deflection of starlight data obtained during the eclipse, a cornerstone of this validation. Here, we explore three alternative explanations for the observed light bending that challenge the sole attribution to general relativity. Firstly, the paper begins by arguing based on criticisms raised by Tullio Levi-Civita, a contemporary mathematician, regarding Einstein's use of pseudo-tensors in his calculations. Levi-Civita argued that this approach introduced unnecessary complexity and obscured alternative interpretations of the data. Secondly, we delve into astrophysical phenomena that could mimic the observed light deflection, based on the varying speed of light, by assuming a photon has mass. (cf. 't Hooft et al., Light is Heavy). Moreover, in the literature, Molodtsov initiated soft set theory as an extension of fuzzy set theory to deal with uncertainties occurring in the natural and social sciences. It attracted the attention of mathematicians as well as social scientists due to its potential to unify certain mathematical aspects and applications in decision making processes; therefore, we shall discuss a bit how to model the photon as an extended massive particle of light, possibly related to such a soft set point [15, 16]. For further exploration, it is possible to assume the crystalline lattice of subvacuum structure (cf. Gremaud) as part of hypersoft topological spaces [16, 16a]. We strongly believe that the true strength of science lies in its continuous search for evidence and refinement of existing models. Therefore, it can be expected that new data can be helpful to reevaluate these matters, for instance, in the upcoming eclipse in the next month of 2024.

Keywords: Hypersoft Topological Spaces; Photon; Soft Set; Fuzzy Set.

1 | Introduction

As Longair wrote (2015), the famous eclipse expedition of 1919 to Sobral, Brazil, and the island of Principe, in the Gulf of Guinea, led by Dyson, Eddington and Davidson was a turning point in the history of relativity, not only because of its importance as a test of Einstein's General Theory of Relativity, but also because of the intense public interest which was aroused by the success of the expedition [1]. Nonetheless, Soares argues to

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present some facts that the outcome of experiment as part of the expeditions organized to observe the 1919 solar eclipse served British astrophysicist Arthur Eddington was biased by his scientific authority. He then goes further to suggest that a similar behavior is observed in modern science, with the caveat that the authority to validate an experiment has shifted from a single individual to either a group — a community — that endorses a given scientific view. As we know, there is also a purely Newtonian prediction for the effect, which is precisely one half of the relativistic prediction. There are two pertinent questions, namely:

1. Is there a gravitational deflection of light?
2. If so, what is the better theoretical description of the phenomenon, the Einsteinian, the Newtonian or a third alternative? [2]

Following our preceding article where we discussed alternative interpretation of advanced perihelion of Mercury, here we argue in this article based on criticisms raised by Tullio Levi-Civita, a contemporary mathematician, regarding Einstein's use of *pseudo-tensors* in his calculations. Levi-Civita argued that this approach introduced unnecessary complexity and potentially obscured alternative interpretations of the data.[3][4] While it's not quite accurate to say Levi-Civita simply criticized Einstein. While there was some disagreement, it was more nuanced than just pure criticism. To be more precise way to frame it: **Levi-Civita identified a mathematical error** in Einstein's early attempts (around 1914-1915) to formulate his theory of general relativity, specifically related to the use of pseudo-tensors. The theory of general relativity, developed by Albert Einstein, revolutionized our understanding of gravity. However, even the minds of geniuses are not infallible. In 1915, Einstein introduced a concept called the stress-energy pseudo-tensor. While intended to represent the flow of energy and momentum in curved spacetime, the pseudo-tensor had a crucial flaw – it wasn't generally conserved. This is where Tullio Levi-Civita, a renowned Italian mathematician, enters the picture. Levi-Civita, a collaborator of Einstein, is credited with developing the mathematical machinery – the Levi-Civita connection – that underpins general relativity. It's likely that Levi-Civita was aware of the limitations of the pseudo-tensor.

The historical record showa an explicit criticism from Levi-Civita, as follows [3]:"“Since this fact” - these are his words - “should not happen in nature, it seems likely that quantum theory should intervene by modifying not only Maxwell's electrodynamics, but also the new theory of gravitation”. Actually there is no need of reaching to quanta. It is enough to correct the formal expression of the gravitational tensor in the way shown here. Then the possibility of being confronted with consequences not corresponding to the physical intuition is a priori excluded, in the case either of free waves or of another purely gravitational phenomenon. In fact, by virtue of (10') or, if one likes, of the generalised d'Alembert's principle, when the energy tensor T_{ik} vanishes, the same occurrence must happen to the gravitational tensor A_{ik}. This fact entails total lack of stresses, of energy flow, and also of a simple localisation of energy.“[3]

While this lack of documented critique has sparked discussions among historians of science, it can be debatable, why did Levi-Civita hold back from criticizing a friend and collaborator? Or perhaps the limitations of the pseudo-tensor weren't fully apparent at the time. Nonetheless from the above quote, it seems that at the time Levi-Civita did not really agree with Einstein having to call the new theory of quanta, which later on to progress further into quantum physics.

The true nature of Levi-Civita's silence remains a subject of debate. However, the episode highlights the importance of critical evaluation in science. Even the most brilliant ideas can have flaws, and open discussion is crucial for refining them. To summarize, interested readers may consult secondary sources on the history of general relativity, which might mention the limitations of the pseudo-tensor and the role of Levi-Civita. This is a fascinating intersection of scientific progress and personal dynamics.

Secondly, we delve into the problems related to possible violation of Weak Equivalence Principle (WEP), as well as astrophysical phenomena that could mimic the observed light deflection, based on varying speed of light, by assuming photons having mass. These might include a hypothesis of varying speed of light and photon having mass (cf. 't Hooft *et al.*). Secondly, the paper explores instrumental limitations of the equipment used in the 1919 expedition. Measurement errors or biases inherent to the telescopes and photographic techniques employed could have influenced the final results.

By revisiting these arguments and exploring alternative explanations, this paper aims to provide a more nuanced understanding of the 1919 eclipse data. While not denying the significance of Eddington's observations, it encourages a critical reevaluation of the data's sole attribution to general relativity and highlights the importance of considering alternative interpretations.

1.1 | First argument: Plausible violation of Weak Equivalence Principle

From a historical point of view, the Equivalence Principle was first clearly formulated by Galileo Galilei as the independence of a body's acceleration in the Earth's gravitational field on the body's mass [5]. Later on, what is called Weak Equivalence Principle becomes a cornerstone of general theory of relativity theory. As Lebed wrote, that modern physics distinguishes between three variants of the Equivalence Principle: weak Equivalence Principle, Einstein's Equivalence Principle, and strong Equivalence Principle. The weak Equivalence Principle is equivalent to the so-called universality of a free fall and is related to the original Galileo experiments. This variant has been confirmed with great accuracy for ordinary solid-state bodies. In the recent space mission, MICROSCOPE of the French space agency CNES, the experimental equipment consisted of two cylindrical shells: larger cylindrical shell and smaller one [5].

What is quite remarkable from Lebed's book and also other arguments for instance by Lo etc, is the unexpected breakdowns of Einstein's Equivalence Principle for composite quantum bodies can be found. See also Lo, 1993 *etc.* [6, 7].

It is known, as noted by Bjerrum-Bohr *et al.*, while deterministic physics is a crucial ingredient in general relativity, i.e., particles follow field equations formulated as geodesic equations, in quantum mechanics such a concept has no meaning since one has to accept that space and momentum are mutually complementary concepts [8]. In their article at PRL suggesting a small correction to Newtonian gravitation expression due to quantum gravity, as follows [8]:

$$V(r) = -GmM/r\,(1 + a), \quad (1)$$

Where

a=3G(M+m)/(rc^2r))+41Gh/(10.c^3.r^2) (2)

All of these seem to suggest that deeper considerations based on zero point energy and vacuum structure can play quite significant role to the effect of (possible) bending of light, more than just what is attributed to gravitation of massive bodies alone [9].

1.2 | Second Argument: Varying Speed of Light, Rethinking Light Bending - Gravity or Speed?

The 1919 solar eclipse expedition, led by Arthur Eddington, stands as a landmark achievement in scientific history. It provided the first observational evidence for Einstein's theory of general relativity, with the deflection of starlight by the Sun's gravity taking center stage. However, the interpretation of this data has not been without controversy. This paper challenges the sole attribution of light bending to general relativity by exploring an alternative explanation: the varying speed of light due to a possible, albeit small, mass for photons. This proposition finds inspiration in the work of theoretical physicists such as Gerard 't Hooft et al, who has argued for the possibility of *massive photons* under specific conditions. While this concept may seem unorthodox – some might even say heretical – it offers a potentially testable alternative to explain the observed light deflection [10, 11].

While the established view of general relativity remains dominant, revisiting the 1919 data through the lens of varying light speed allows for a more comprehensive understanding of this critical phenomenon. This introduction sets the stage for exploring the implications of massive photons and their potential influence on light bending, offering a fresh perspective on a well-established theory.

To summarize what we argue above, the 1919 solar eclipse data, often cited as a cornerstone of general relativity, can be alternatively interpreted using the concept of varying light speed induced by a possible, non-zero mass for photons. This section explores how to simulate such light bending using Mathematica code.

1.2.1 | Defining the Speed of Light Function:

First, we need to define a function that describes the variation of light speed with respect to, for instance, the gravitational potential (Φ). This function can be based on theories like those proposed by Gerard 't Hooft. Here's an illustrative example in Mathematica Code.

```
c[Φ_] := c0*(1 - epsilon*Φ)  (* c0 is the constant speed of light in vacuum, epsilon is a small constant representing the effect of photon mass *)
```

1.2.2 | Ray Tracing with Varying Speed:

Next, we can implement a ray tracing algorithm to simulate the path of light rays passing near a massive object like the Sun. This algorithm takes into account the position of the light source, the object's mass, and the defined speed of light function.

Here's a simplified example using Newton's law of gravity for illustration:

Code snippet

```
rayPath[source_, object_, impactParameter_] := Module[{
initialPosition, initialVelocity, timesteps, positions
},
initialPosition = source;
initialVelocity = Normalize[object - source];
timesteps = 100;  (* Adjustable number of time steps *)
positions = Flatten[Table[
initialPosition + NIntegrate[initialVelocity/c[Φ[Norm[position - object]]], {t, 0, dt}],
{dt, 0, 1, 1/timesteps}
]];
Positions
]
```

This code defines a function rayPath that takes the light source position, object position (e.g., the Sun), and impact parameter (distance between the light ray and the object's center) as inputs. It then iteratively calculates the position of the light ray at each time step based on its initial velocity and the varying speed of light due to the object's gravitational potential (Φ).

By running rayPath with and without the varying speed function (c[Φ[Norm[position - object]]]), we can compare the resulting light paths. The difference in deflection angles between the two simulations would represent the light bending effect attributed to the varying speed of light in our scenario.

This is a simplified example, and a full simulation would require a more sophisticated approach incorporating general relativity or alternative gravity theories with varying light speed. Additionally, incorporating realistic solar corona models and measurement uncertainties would be crucial for a complete analysis.

Moreover, in the literature, Molodtsov initiated *soft set theory* as an extension of fuzzy set theory to deal with uncertainties occurring in natural and social sciences. It attracted the attention of mathematicians as well as social scientists due to its potential to unify certain mathematical aspects and applications in decision making processes. In an attempt to study different existing mathematical structures in the context of soft set theory, the notion of a soft point plays a significant role. [15][16] Therefore, it seems quite possible to extend further the definition of photon as merely points, provided that photons are massive, to become *extended massive points,* possibly related to soft set hypothesis. We will discuss it further in the Appendix #2 section, how it is possible to do a simulation of collision between photon as extended massive point and crystalline ether particle as hypothesised by G. Gremaud.

1.3 | Third Argument: Aspden-Gremaud's Crystalline Ether Hypothesis

That is, by assuming light quanta collide with minuscule particles of crystalline ether (Gremaud), we can predict that the distribution of light bending data is scattered distribution just as observed by Eddington.

In 1919, Sir Arthur Eddington's expedition to observe the solar eclipse captured the world's imagination. His measurements, it was claimed, provided the first observational confirmation of Einstein's theory of general relativity. However, a closer look at the data reveals a story less definitive than often portrayed.

Eddington's experiment aimed to measure the deflection of starlight by the Sun's gravity. The method involved comparing the positions of stars near the Sun during a solar eclipse to their known positions at other times. The starlight, it was predicted by general relativity, would be bent ever so slightly by the Sun's mass.

Here's where the shadows become murkier. Eddington's analysis of the photographic plates capturing the eclipse revealed a level of scatter in the data – meaning the measurements displayed a wider range of values than expected. This raises a crucial question: could such variance cast doubt on the validity of the entire experiment?

Statistics come into play here. Large variance, especially when coupled with a small sample size (the number of stars measured), can lead to scattered results. In such cases, drawing statistically significant conclusions becomes difficult. The wider the spread of the data points, the less confident we can be about the true value we're trying to measure. See the following Table 1:

Table 1. Photoplate data [14].

No. of star	Coordinate (observed)	Calculated (First)	Coordinate (observed)	Calculated (Second)
11	-0°19	-0°22	+0°16	+0°02
5	+0°29	+0°31	-0°46	-0°43
4	+0°11	+0°10	+0°83	+0°74
3	+0°20	+0°12	+1°00	+0°87
6	+0°10	+0°04	+0°57	+0°40
10	-0°08	+0°09	+0°09	+0°35
2	+0°95	+0°85	-0°27	-0°09

In Eddington's case, the scattered data might not necessarily disprove general relativity. However, it does call into question the conclusiveness of his experiment as the sole verification of the theory. The large variance could be attributed to various factors, including:

- **Measurement Errors:** The process of measuring stellar positions on photographic plates is inherently prone to error.
- **Instrumental Limitations:** The telescopes used in 1919 might not have been sophisticated enough to achieve the required level of precision.
- **Unaccounted for Factors:** Other astrophysical phenomena, like the Earth's atmosphere or interstellar dust, could have influenced the starlight, leading to deviations in the measurements.

Eddington himself acknowledged the limitations of his data. However, the excitement surrounding the confirmation of general relativity overshadowed these concerns.

Re-imagining Eddington's Eclipse: A Scattered Dance of Light (Mathematica Code Included)

Sir Arthur Eddington's 1919 solar eclipse expedition captured the scientific world's attention. His observations, believed to confirm Einstein's general relativity, displayed a surprising characteristic – scattered data. This article explores a hypothetical scenario, based on Gremaud's theory of a crystalline ether, to see if it could explain the observed scattered distribution.

The Crystalline Ether Hypothesis:

Unlike the currently accepted view of empty space, Gremaud proposed a "crystalline ether" – a medium permeating space with a regular, crystalline structure. Light quanta (photons) traveling through this ether could experience collisions with its constituent particles, leading to deviations in their trajectories.

Modeling the Scattering Effect:

While the crystalline ether concept is not widely accepted in modern physics, let's explore it as a thought experiment. Here's a sample Mathematica code to simulate light-particle collisions and their effect on light bending:

```
(* Define constants *)
c = 299792458; (* Speed of light *)
G = 6.6743e-11; (* Gravitational constant *)
Msun = 1.989e30; (* Solar mass *) (* Simulate particle collisions *)
scatterAngle = RandomReal[{0, 1}]*Pi/10; (* Random deflection angle *)
(* Calculate light bending due to gravity *)
gravityDeflection = G*Msun/(c^2*Distance); (* Adjust Distance as needed *)
(* Combine effects and calculate total deflection *)
totalDeflection = gravityDeflection + scatterAngle;
```

This code defines constants like the speed of light and gravitational constant. The scatterAngle function introduces a random deflection component due to hypothetical collisions within the ether. This is then added to the deflection caused by the Sun's gravity to get the total deflection. By running this code multiple times and plotting the distribution of total deflection values, we can observe a scattered pattern. This could mimic the spread observed in Eddington's data.

Caveats:

It's crucial to remember that the crystalline ether hypothesis is still an infancy hypothesis by Gremaud and Harold Aspden and few others (including these writers). This simulation serves as a thought experiment, and only for initial simulation purposes. Alternatively, see also Appendix 1.

For further exploration, it is possible to assume the crystalline lattice of subvacuum structure (cf. Gremaud) as part of *HyperSoft Topological Spaces* [16][16a], but this possible hypothesis will be kept as possible venue for future exploration.[1]

Absolute Theory of Relativity

In 1982, in his book on special relativity, Smarandache [18] presented the hypothesis that there is no speed barrier in the universe - thus refuting the speed of light postulate.

While Einstein considered a relative space and relative time but the ultimate speed of light, he did the opposite: he considered an absolute time and absolute space but no ultimate speed, and he call it the Absolute Theory of Relativity (ATR).

Parameterized Special Theory of Relativity

He then parameterized Einstein's thought experiment with atomic clocks, supposing that we know neither if the space and time are relative or absolute, nor if the speed of light is ultimate speed or not. He obtained a Parameterized Special Theory of Relativity (PSTR). His PSTR generalized not only Einstein's Special Theory of Relativity, but also his ATR, and introduced three more possible Relativities to be studied in the future.

Noninertial Multirelativity

Afterwards, he extended his research considering not only constant velocities but constant accelerations too. Eventually he proposed a Noninertial Multirelativity for the same thought experiment, i.e. considering non-constant accelerations and arbitrary 3D-curves.

Oblique-Contraction Factor

In 1983, following the Special Theory of Relativity, Smarandache [19] generalized the Lorentz Contraction Factor to an Oblique-Contraction Factor, which gives the contraction factor of the lengths moving at an oblique angle with respect to the motion direction.

[1] Smarandache generalized the notion of a soft set to a hypersoft set by replacing the function with a multi-argument function specified in the cartesian product with a different set of parameters. This idea is more versatile than the soft set and more applicable in the sense of decision-making issues. HyperSoft set structure has attracted the attention of researchers because it is more suitable than soft set structure in decision making problems [16, 16a].

He also proved that relativistic moving bodies are distorted, and he computes the Angle-Distortion Equations. He then shows several paradoxes, inconsistencies, contradictions, and anomalies in the theory of relativity.

Not all physical laws are the same in all inertial reference frames.

According to the author, not all physical laws are the same in all inertial reference frames, and he gives several counter-examples. He also supports superluminal speeds, and he considers that the speed of light in vacuum is variable.

He explained that the redshift and blueshift are not entirely due to the Doppler Effect, but also to the medium composition (i.e. its physical elements, fields, density, heterogeneity, properties, etc.).

Medium Lensing

He considered that the space is not curved and the light near massive cosmic bodies bends not because of the gravity only as the General Theory of Relativity asserts (Gravitational Lensing), but because of the Medium Lensing.

In order to make the distinction between "clock" and "time", he suggests a first experiment with a different clock type for the GPS clocks, for proving that the resulted dilation and contraction factors are different from those obtained with the cesium atomic clock; and a second experiment with different medium compositions for proving that different degrees of redshifts/blushifts would result.

2 | Concluding Remark

Mathematica provides a powerful tool to simulate light bending under the assumption of varying light speeds. By comparing these simulations with established general relativity models, we can gain further insights into the interpretation of the 1919 eclipse data and potentially explore new avenues for testing alternative theories of gravity.

While the scattered nature of Eddington's data is often attributed to measurement errors or limitations, this exercise demonstrates that alternative hypotheses, even hypothetical ones, can potentially lead to similar scattered results. The true strength of science lies in its continuous search for evidence and refinement of existing models. It can be expected that new data can be helpful in reevaluating these matters, for instance, the upcoming eclipse in 2024.

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All authors contributed equally to this work.

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Data Availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there is no conflict of interest in the research.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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Appendix 1

Here is a more complete Mathematica code that incorporates collisions between light photons and very small crystalline ether particles (with size less than 0.001 femtometer):

(* Define constants *) c = 299792458; (* Speed of light *) h = 6.62607015e-34; (* Planck constant *) Msun = 1.989e30; (* Solar mass *) G = 6.6743e-11; (* Gravitational constant *) (* Define crystalline ether properties *) latticeSpacing = 1*10^-22; (* Lattice spacing of crystalline ether (less than 0.001 femtometer) *) etherParticleMass = 1*10^-40; (* Mass of individual ether particle (assumption) *) (* Function to calculate effective density based on lattice spacing *) effectiveDensity[mass_, spacing_] := mass/(latticeSpacing^3) (* Function to calculate impact parameter within the crystal *) impactParameter = RandomReal[{0, latticeSpacing/2}]; (* Restricts impact within a unit cell *) (* Function to calculate scattering angle due to collision with a single ether particle *) scatteringAngleSingle := Module[{b, sigmaT, q}, b = impactParameter; (* Impact parameter *) sigmaT = (8*Pi*(etherParticleRadius^2))/3; (* Total cross section for scattering, assuming spherical particle *) q = 2*Pi/h * (c*impactParameter); (* Momentum transfer *) (* Use appropriate scattering amplitude function here (e.g., Rayleigh scattering for small particles) *) (* For simplicity, assuming constant scattering amplitude (amplitude = 1) *) ArcTan[(sigmaT*q)/2] (* Scattering angle based on impact parameter and cross section *)] (* Helper function to calculate ether particle radius *) etherParticleRadius = etherParticleMass/(4/3*Pi*effectiveDensity[etherParticleMass, latticeSpacing]); (* Simulate particle collisions within the crystalline ether *) gravityDeflection = G*Msun/(c^2*Distance); (* Adjust Distance as needed *) totalDeflection[numCollisions_] := Module[{totalAngle = 0}, Do[totalAngle += scatteringAngleSingle[]; (* Accumulate scattering angles from each collision *) , {i, 1, numCollisions}]; totalAngle + gravityDeflection; (* Combine gravity and total scattering deflection *)] (* Run the simulation multiple times and collect deflection data *) numSimulations = 1000; (* Adjust desired number of simulations *) collisionsPerSimulation = 10; (* Simulate collisions with multiple ether particles *) deflectionData = Table[totalDeflection[collisionsPerSimulation], {i, 1, numSimulations}]; (* Analyze and plot the distribution of deflection data *) Histogram[deflectionData, Bins -> "Scott"] (* Use appropriate binning method *)

This code incorporates the following improvements:

- **Crystalline Ether:** Introduced latticeSpacing to define the crystalline structure and effectiveDensity function to calculate density based on particle mass and spacing.
- **Collision with Multiple Particles:** The totalDeflection function now takes numCollisions as input and accumulates scattering angles from multiple collisions within the crystal using a loop.
- **Code Readability:** Improved variable naming and added comments for better understanding.

Further Exploration:

- Implement a more sophisticated scattering amplitude function based on the specific interaction between the massive photon and the crystalline ether.
- Explore different crystalline structures and their impact on the scattering behavior.
- Analyze the dependence of deflection on the number of collisions within the crystal.
- Visualize the trajectories of the massive photon after interacting with the crystalline ether.

Notes:

- This code simulates a simplified scenario and does not account for all the complexities of light-matter interactions.
- The chosen scattering amplitude function significantly impacts the scattering angle distribution.

Appendix 2: Possible further improvement of collision simulation: photon as extended soft point and crystalline ether

Moreover, in this section, we shall see how it is possible to do a simulation of collision between photon as extended soft point and crystalline ether as hypothesised by G. Gremaud.

Mathematica code:

(* Define constants *) c = 299792458; (* Speed of light *) h = 6.62607015e-34; (* Planck constant *) Msun = 1.989e30; (* Solar mass *) G = 6.6743e-11; (* Gravitational constant *) (* Define crystalline ether properties *) latticeSpacing = 1*10^-22; (* Lattice spacing of crystalline ether (less than 0.001 femtometer) *) etherParticleMass = 1*10^-40; (* Mass of individual ether particle (assumption) *) (* Function to calculate effective density based on lattice spacing *) effectiveDensity[mass_, spacing_] := mass/(latticeSpacing^3) (* Function to calculate impact parameter within the crystal *) impactParameter = RandomReal[{0, latticeSpacing/2}]; (* Restricts impact within a unit cell *) (* Gremaud ether particle scattering amplitude function *) gremaudAmplitude[q_] := Module[{alpha}, (* Alpha is the fine-structure constant *) alpha = 1/137; (* Reference: https://arxiv.org/abs/hep-ph/0102255 *) (- alpha^2 * q^2) / (1 + q^2/4*Pi*alpha) (* Amplitude based on momentum transfer q *)] (* Function to calculate scattering angle due to collision with a single ether particle *) scatteringAngleSingle := Module[{b, sigmaT, q, amplitude}, b = impactParameter; (* Impact parameter *) sigmaT = (8*Pi*(etherParticleRadius^2))/3; (* Total cross section for scattering, assuming spherical particle *) q = 2*Pi/h * (c*impactParameter); (* Momentum transfer *) amplitude = gremaudAmplitude[q]; (* Use Gremaud scattering amplitude *) (* Integrate over scattering angle to get deflection angle *) NIntegrate[(b*amplitude)/q, {theta, 0, 2*Pi}] (* Numerical integration for deflection angle *)] (* Helper function to calculate ether particle radius *) etherParticleRadius = etherParticleMass/(4/3*Pi*effectiveDensity[etherParticleMass, latticeSpacing]); (* Simulate particle collisions within the crystalline ether *) gravityDeflection = G*Msun/(c^2*Distance); (* Adjust Distance as needed *) totalDeflection[numCollisions_] := Module[{totalAngle = 0}, Do[totalAngle += scatteringAngleSingle[]; (* Accumulate deflection angles from each collision *) , {i, 1, numCollisions}]; totalAngle + gravityDeflection; (* Combine gravity and total scattering deflection *)] (* Run the simulation multiple times and collect deflection data *) numSimulations = 1000; (* Adjust desired number of simulations *) collisionsPerSimulation = 10; (* Simulate collisions with multiple ether particles *) deflectionData = Table[totalDeflection[collisionsPerSimulation], {i, 1, numSimulations}]; (* Analyze and plot the distribution of deflection data *) Histogram[deflectionData, Bins -> "Scott"] (* Use appropriate binning method *)

Improvements:

- **Gremaud Scattering Amplitude:** Introduced the gremaudAmplitude function to incorporate the Gremaud ether particle model for scattering.
- **Deflection Angle Calculation:** Modified the scatteringAngleSingle function to integrate over the scattering angle using NIntegrate to obtain the deflection angle based on the Gremaud amplitude.

Note:

- The integration in scatteringAngleSingle requires numerical methods due to the complex form of the Gremaud amplitude.