If the S_P dimension stretches, it will reduce the value of the Planck density and the energy density constraint will squeeze out a component of vacuum energy as standard model photons.

Results and Discussion

Energy scale of reheat photons

The maximum energy of the reheat photons that can be emitted in the resulting spectrum can be described by,

$$E_{\max} = h_0 E_P \tag{21}$$

Where,

E_P=Planck energy.

h_0=Effective strain for the S_P dimension. And,

$$h_0 = \frac{hf_g - H_0^*}{f_g} \tag{22}$$

Where,

f_g=Gravitational wave frequency.

h=Strain and both represent the threshold that has to be exceeded for reheating to occur.

=Equivalent Hubble constant associated with each cubic Planck volume describing the expansion rate of S_0 dimension.

H =Proportional to the curvature of the visible 3d spatial dimension S_1 and hardens the S_P dimesions against gravitational wave vibration.

Magnetic softening of the S_P dimension

The magneto curvature coupling aspect of general relativity was explored based on its tendency to flatten curvature and even dampen gravitational waves [17]. The key aspects of this coupling, is the vector nature of the magnetic field and the magnetic tension that tends to straighten the field lines against distortion by curved space time background.

Essentially the distortion of the field lines by curved background or a passing gravitational wave causes a back reaction from such magnetic field, flattening the curvature or ripples in the fabric of space time. This dampens the gravitational wave amplitude and energy, and can be seen as the hardening of the visible spatial dimensions against gravitational oscillation.

Within the Rute framework, the expansion rate of the S_0 dimension is a measure of spatial curvature. Therefore the flattening of space time curvature suppresses in equation (22), resulting in the softening of S_P dimension which becomes more sensitive to gravitational wave oscillation. Indeed with a flat geometry which implies 0, equation (22) becomes,

$$h_0 = h \tag{23}$$

Where the strain h_0 of S_P vibration becomes equal to the strain h of the incident gravitational wave resulting in maximum reheating. In essence, a strong magnetic field like that obtainable around magentas softens the S_P dimension by lowering the threshold strain and frequency required for reheating to occur for incident gravitational waves.

Strictly from energy conservation perspective, the energy lost by gravitational waves passing through a strongly magnetized region has to be released in some form and Rute's GWR provides the mechanism for converting the gravitational wave energy into electromagnetic one. It is expected that the brief burst of electromagnetic waves radiated while the gravitational wave passes through a strongly magnetized region such as magentas, encodes information about the incident gravitational waves. These burst of electromagnetic radiation can appear as Fast Radio Burst (FRBs) or even Gamma Ray Burst (GRBs) depending on source proximity or strain and frequency of the incident gravitational waves, making magnetars possible astrophysical gravitational wave detectors.

Dark matter from vacuum energy

The bare vacuum energy component should always be gravitationally inert with its existence in the G_0=0G state where the gravitational field is effectively switched off. However, in this framework, particle substrates of the standard model such as neutrinos affects their background while in the inert state such that G_0>0G.

Within such background in the inert state, neutrinos provides some gravitational illumination described by equation (24) that enables virtual particles to gravitate with positive pressure appearing as dark matter.

$$G_\nu = \beta\Gamma^2 G \tag{24}$$

Where,

G_ν=Induced gravitational constant in the inert state due to the background effect of neutrino substrates.

β=Dimensionless free parameter and the value varies with neutrino flavor and energy. It varies from 1 and approaches infinity as neutrino speed approaches speed limit c. Γ is the same asymmetry parameter involved in the emergence of dark energy.

With the expression of Γ in equation (7), equation (24) becomes,

$$G_\nu = \frac{4\pi^2\beta G}{l_0^2} \tag{25}$$

Where l_0 is the size of the S_0 dimension (in Planck unit) which is proportional to the absolute value of the gravitational potential Φ and suppresses this substrate effect of neutrinos and hence the near absence of dark matter effect in deep gravitational potential wells.

The value of G_ν falls off quickly within the range of the weak interaction indicating a possible link between the value of G and the weak interaction.

While hot dark matter is the form of dark matter that can be produced by relativistic neutrinos, cosmic neutrinos are unrelativistic. Such non relativistic cosmic neutrino substrates should be further slowed down by the Higgs like drag from its self-induced gravitational interaction with virtual particles within its background. This enhances the clustering of cosmic neutrino substrates and the gravitating virtual particles in their background appear as cold dark matter.

The potential suppression of G_ν enables this substrate dependent form of dark matter to have hybrid behavior by mimicking modified gravity form of dark matter such as Modified Newtonian Dynamics (MOND) while also exhibiting some particle behavior of its neutrino substrates like the superfluid dark matter described in [18]. The details of its unique properties will be discussed in subsequent papers [19-21].

Conclusion

Rute provides an elegant framework for the resolution of the cosmological constant problem of dark energy and the nature of dark matter. In doing so it provides a deeper insight into the dimensional structure of space time and chain of causality involved in gravitation. Specifically, it places the bare vacuum energy component in a state where the gravitational field is switched off with actual gravitational constant $G_0=0G$, while real standard model particles oscillate between this gravitationally inert state and the active state.

Due to an energy density constraint and a speed limit asymmetry that limits the capacity of the inert state to contain the entire vacuum energy component, a small component spills into the active state as dark energy. The asymmetry parameter emerges from a key dimensional symmetry and it is the ratio of the size of the spatial equivalent of time S_0 and its microscopic partner S_P.

The illuminating effect of neutrino substrates particularly cosmic neutrinos, induces non zero gravitational constant in the inert state, providing gravitation for virtual particles which appears as dark matter. This baryonic substrate dependent form of dark matter can exhibit hybrid characteristics of particle dark matter and modified gravity form of dark matter like superfluid dark matter. It also indicates a possible link between the value of G and the weak interaction.
The reheating prediction in which gravitational waves produce electromagnetic secondary's with negative pressure from strong magnetic fields of magnetars and dark energy might be the sources of Fast Radio Bursts (FRBs) and Excess Radio Background (ERB).

In conclusion, the Rute framework offers new physics explanations for dark energy and dark matter as different manifestations of vacuum energy that can be tested and provides deep insights into the dimensional structure of space time and gravity.

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