On the Experimental Failure to Detect Dark Matter

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Abstract

It is argued that the failure of dark matter experiments to verify its existence may be attributable to a *non-Planckian* 'action,' which renders dark matter's behavior contradictory to the consequences of quantum mechanics as it applies to luminous matter. It is pointed out that such a possibility cannot be convincingly dismissed in the absence of a physical law that prohibits an elementary 'action' smaller than Planck's. It is further noted that no purely dark matter measurement of Planck's constant exists.

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The search for dark matter (DM) remains one of the most vexing of the unresolved problems of contemporary physics. While the existence of DM is no longer in dispute, its composition is a matter of lively debate. A variety of subatomic particles with exotic properties have been proposed as possible candidates. However, as is well known by now, after more than three decades of experimentation, and considerable expenditure, none have yet been detected. If the past is any guide, such negative results often force us to radically reexamine some of the basic tenets underlying physical concepts. It is the purpose of this paper to propose a plausible, experimentally verifiable, explanation for the persistent failure of *particle* DM experiments to yield positive results.

Since DM's existence is inferred solely from its gravitational effects, and its nature is otherwise unknown, one cannot rule-out the possibility that DM's behavior may be contradictory to the consequences of quantum mechanics as it applies to luminous matter (LM), which is particularly troubling since it necessarily brings into question the applicability of Planck's constant as a viable 'action' in this *non-luminous* domain. It is important to point out that no purely DM measurement of Planck's constant exists. Indeed, all that we know about Planck's constant is based on electromagnetic and strong interaction experiments, whose particles and fields account for only 4.6% of the mass-energy density of the observable universe, which pales when compared to the 23.3% attributable to DM.

It has been observed astronomically that large aggregates of DM pass right through each other without colliding [1], which is clearly significant since it essentially rules out the idea that particles of DM can somehow interact and collide with each other. Equally revealing, analysis of cosmic microwave background observables has provided conclusive evidence that DM is made up of slow-moving particles [2], a development that has firmly established the cold DM paradigm as the centerpiece of the standard cosmology. Taken together these astronomical findings are suggestive of a non-interacting, non-relativistic particle whose coherent mode of behavior is a characteristic property of *classical* light (i.e., non-quantum). Clearly, if such a particle exists, the condition of quantization can only become a physical possibility if its 'action' is considerably smaller than Planck's.

Whether or not we know DM's nature, the undisputed fact remains that *all* elementary particles exhibit wavelike properties. Hence, if DM's behavior is orchestrated by a *non-Planckian* 'action' it should be possible to describe such particle waves in the context of the framework of quantum mechanics, whose conceptual basis allows *only* two possible *immutable* 'actions.' Namely, Planck's familiar constant, h, which has been shown experimentally to play a crucial role in the microphysical realm, and the not so familiar, more diminutive 'action' e^2/c (denoted by the symbol j for simplicity of presentation). While this *non-Planckian* constant appears to have no discernible role in our luminous world, it is, nevertheless, clearly of interest since it may be sufficiently smaller than Planck's constant to account for DM's astronomical behavior; a possibility that cannot be convincingly dismissed in the absence of a physical law that prohibits an *elementary* 'action' smaller than Planck's.

In order to facilitate matters we shall assume that DM's non-Planckian *particle/wave* properties are consistent with both the Einstein relation for the total energy of a particle, in the form

$$E = jf = mc^2 = \frac{m_0 c^2}{(1 - v^2/c^2)^{1/2}} \tag{1}$$

and the de Broglie relation for the momentum

$$p = \frac{j}{\lambda} = mv = \frac{m_0 v}{(1 - v^2/c^2)^{1/2}} \tag{2}$$

where $j = 7.6956 \times 10^{-30}$ erg s is the conjectured DM 'action' quantum, which may be compared with the Planck constant, h, found in our luminous world (i.e., 6.6260×10^{-27} erg s). Now, since the relation between energy and momentum in *classical* mechanics is simply

$$E = \frac{1}{2m} p^2 \tag{3}$$

we can replace E and p with the differential operators

$$E = i(j/2\pi) \frac{\partial}{\partial t} \tag{4}$$

and

$$p = -i(j/2\pi) \frac{\partial}{\partial x} \tag{5}$$

and operate with the result on the wave function $\psi(x, t)$ that represents the de Broglie wave. We then obtain

$$i(j/2\pi) \frac{\partial \psi}{\partial t} = -\frac{(j/2\pi)^2}{2m} \frac{\partial^2 \psi}{\partial x^2}, \tag{6}$$

which is Schroedinger's general wave equation for a *free* particle in a one dimensional space. Its solution describes a *non-Planckian* particle that is the quantum mechanical analog of a *non-interacting,* non-relativistic, *classical* particle that is moving in the x direction with constant velocity; a result that closely mirrors DM's elusive behavior, and can be simply explained in the context of this generalization. That is, the classical concept of two particles exerting a force on each other corresponds to the quantum mechanical concept that the de Broglie wave of one particle influences the de Broglie wave of another particle. However, this is only possible if the de Broglie wave propagates *non-linearly,* in sharp contrast with Schroedinger's general wave equation for which the propagation of waves is described by a *linear* differential equation. Hence the presence of one wave *does not* affect the behavior of another wave, allowing them to pass right through each other without colliding, which is consistent with the results of the aforementioned astronomical observations [1].

If it exists, this non-Planckian particle would easily have eluded detection because of the diminutive magnitude of the non-Planckian 'action.' More explicitly, the closer you come to the *classical* limit the *less* pronounced are the quantum effects. As a result, this non-Planckian particle is expected to behave more like a wave than a particle, indifferent to existing DM experiments, which are specifically designed to detect *particle* interactions. Of course it is entirely possible that this non-Planckian particle has already been observed but the experimenters did not recognize what they saw. However, given the fact that this is a different kind of particle altogether, it is more likely that its detection will require the use of a wholly different set of experimental tools.

Finally, we come to a very important question. What name to give this non-Planckian particle. It has long been a tradition in particle physics to select names with a particle spelling ending in *-on*. Logically speaking, "*warpton*" would be an appropriate name since it acknowledges this particle's indispensable role in enabling the *warping* of spacetime sufficiently enough to cradle billions of galaxies, while at the same time continuing this long tradition. Clearly, the introduction of this *cold DM non-Planckian particle,* in the context of quantum mechanics, provides a fundamentally plausible means of explaining the failure of conventional experiments to detect DM. After these many decades of null experimental results, the time has come to acknowledge the possibility that DM's behavior may be orchestrated by a richer variety of *fundamentally* different mechanisms than previously recognized.

References

[1] D. Clowe et al., Astrophys. J. **648,** L109 (2006).

[2] A.D. Lewis et al., Astrophys. J. **586,** 135 (2003).

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