On Fine Structured Spacetime as a New Hypothesis for Dark Energy and Dark Matter

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Abstract

We propose a new hypothesis that could potentially have far-reaching consequences for the amount of Dark Energy and Dark Matter required in ΛCDM model. The new hypothesis proposes the development and existence of fine structural changes in the signature of the spacetime curvature contributions from subatomic particles arriving from far distant parts of the universe, which disrupt and reduce the effects of gravity over those distances. It's proposed that when this structured spacetime passes through a baryonic body, it's re-smoothed, scrambling any such signature in the spacetime curvature, releasing radiation and a backscattered gravitational potential. This shielding effect then casts a smoothed spacetime curvature shadow on a second baryonic body, which acts normally on the body. For a test particle near the edge of a galaxy, it's shown how this could allow a particle to have a constant rotational velocity that is not dependent on the orbital radius. Hence the hypothesis seems to reproduce the linear Tully-Fisher relationship: $\log(V) \propto \log(M)$, and could form the physical underpinnings behind the highly successful Milgrom's empirical law. It also described how forces predicted by the hypothesis could extend to very large distances up to ~10-100Mpc, far beyond the inverse square law, possibly explaining several galactic and cosmic phenomena. We survey unexplained cosmological observations to see if the new hypothesis could help solve any such conflicts between observation and known theory. We report a seemingly remarkable ability for FiSS to fit unexplained phenomena, including, possibly explanations for spiral arms, barred galaxy structures, star formation in trailing gases for "Jellyfish Galaxies," ring galaxies like Hoag's object, the "vacuum catastrophe" problem, the Hubble constant and the "Crisis in Cosmology," the "Cuspy-Core" problem and many more which we detail here. We also describe how the new hypothesis predicts several falsifiable effects.

Key Words: Dark energy, Dark matter

1. Introduction

A fascinating debate has raged over the existence and true nature of both Dark Energy[1] and Dark Matter,[2] [3] both of which seem to be required when applying Einstein's General Relativity (GR) on a cosmological scale in explaining our universe and galaxy structures. GR has been so conclusively verified; it's hard to envisage there is any room for an alternative modified gravity theory. Some have suggested, any new theory of gravity has to explain Dark Matter and Dark Energy, but also reproduce the predictions of GR.

Einstein introduced the cosmological constant[4] as a type of fudge factor into his field equations of GR to balance the effects of gravity and create a static universe. Today's experiments clearly show the universe to be undergoing accelerated expansion,[5] as evidenced by type Ia supernovae, Cosmic Microwave Background measurements, and large-scale structure studies. Dark Energy is required to produce an accelerating universe, functioning as a form of anti-gravity and negative pressure. However, recently a failed attempt was made to detect a new force to directly observe Dark Energy,[6] resulting in only Newtonian gravity.

Similarly, Dark Matter is invoked as a means to describe certain observed phenomena - the most well known is the rotation curve of spiral galaxies and many more, which we shall discuss later. However, it seems like Dark Matter can be anything and take on any form. Non-interacting, weakly-interacting, multi-species, "cold," "warm," "hot," there are even suggestions that a Dark Matter Disk exists on the same plane as our galaxy, formed from weakly self-interacting Dark Matter. As well as subhaloes floating around our galaxy, need to explain structures observed in "streams." It seems like we need ever different forms of Dark Matter every time we observe an anomaly, which would strongly indicate we're missing some new physics,[7] something deeper.

Certainly, a "zoo" of different Dark Matter particle species would be needed thus far; however, to date (apart from neutrinos), we still have yet to find any direct evidence of Dark Matter. The only evidence seems to come from changes to the gravitational fields baryons experience.

We know GR is fundamentally a macroscopic approximation, albeit a spectacularly successful one! But it's incomplete, we know this with certainty, yet instead of focusing on a "theory of everything," we seem to have assumed that any such "theory of everything," whatever it is, won't fix the numerous inconsistencies in observations today and it won't nullify the need for mysterious concepts like Dark Matter and Dark Energy? How can this possibly be a reasonable assumption?

Alternative suggestions such as Modified Newtonian Dynamis (MOND)[8] are very successful at describing various systems,[9] including wide binaries which Dark Matter theories would have difficulty explaining and would invoke the need for yet another type of tightly bound Dark Matter. However, MOND is merely an empirical observation postulating an unexplained force. It uses an arbitrary transition function that changes the behavior from Newtonian dynamics at large acceleration, to MOND behavior at low accelerations, with no physical explanation for either.

In this work, we propose a simple new hypothesis termed Fine Structured Spacetime (FiSS), for Dark Matter and Dark Energy that predicts four hypothetical force effects acting on galactic scales. It's shown that in one particular case, the FiSS hypothesis seems to reproduce MOND[10] like behavior, providing a physical mechanism behind MONDs acceleration a_0 and the transition function. We survey unexplained phenomena to see if the phenomena are consistent with the new hypothesis or inconsistent and find an astoundingly fit. However, since the new mechanism involves coupling between high curvature spacetime and subatomic particles on a quantum level, requiring an as yet to be discovered non-flat spacetime curvature quantum mechanics theory, unfortunately, the discussion is quite vague and speculative.

2. Fine Structured Spacetime Hypothesis

Ripples in spacetime curvature[11] caused by extremely heavy stellar objects is an uncontroversial concept these days.[12] But it would seem absurd to consider minute spacetime fluctuations caused by subatomic particles, quarks, nucleons, atomic nuclei, electrons. The question we put forward - does this position hold over very long, near universe scale distances, as individual superpositioned fluctuations travel through void space? What could happen over such long distances?

Here we hypothesize Fine Structured Spacetime (FiSS) arises over such distances, namely, spacetime curvature fluctuations,[2] from the internal movement and accelerations of subatomic particles[3] in distant objects, with fluctuation on a wavelength scale as low as $\sim 10^{-18}$m, travel billions of light-years across the universe and becoming ever planar. These fluctuations are proposed to organize into a sharply rippled, finely structured spacetime with very high small scale curvatures. Taking it one step further, perhaps individual fluctuations, part of a massively superimposed[4] ensemble of fluctuations, self-interact over these very long distances growing ever sharper. Since spacetime fabric is essentially wave-like in nature, it's also possible, or even likely, there are constructive/destructive interference patterns that build up as fluctuations travel through sparse ions in cosmic void space, as there seems to be some evidence void space is required in the creation of the hypothesized waves. Perhaps this happens much like a multi-slit diffraction pattern that shows highly localized intensity peaks. Further, it's hypothesized there is a localization of these spacetime curvature peaks in both the z and x-y directions. Perhaps there could be a threshold curvature where the spacetime curvature becomes self-cohesive into something like a wave packet like a gravitational soliton[13] or perhaps like the theorized graviton.[14]

In this picture spacetime curvature is made up of an endless sea of superimposed fluctuations, all traveling in different directions, all seemly infinitesimally small, but the fluctuations traveling in the same direction, in the same region of space, need only to phase shift and reorganize a minuscule distance of 10^{-15}-10^{-18}m, and they have billions of light-years[5] worth of space in which to do so.

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[2] Or possibly some unknown non-radiative gravitational wave modes

[3] Including fluctuations from quarks, nucleons, atomic nuclei and electrons.

[4] It has been hypothesized that the space-time curvature cannot maintain superpositions. However, we assume here that it can, and that these superimposed waves would interact with each other, as we would like to explore our hypothesis. Our position seems to imply that the spacetime curvature at any point is built from an ensemble of superimposed contributions from all elementary particles within the speed of light contact of that point.

[5] Here we're assuming that either time has not completely frozen for gravitational fluctuations, or there is a mechanism that can allow this to happen.

2.1 Smoothed Fine Structured Spacetime Force

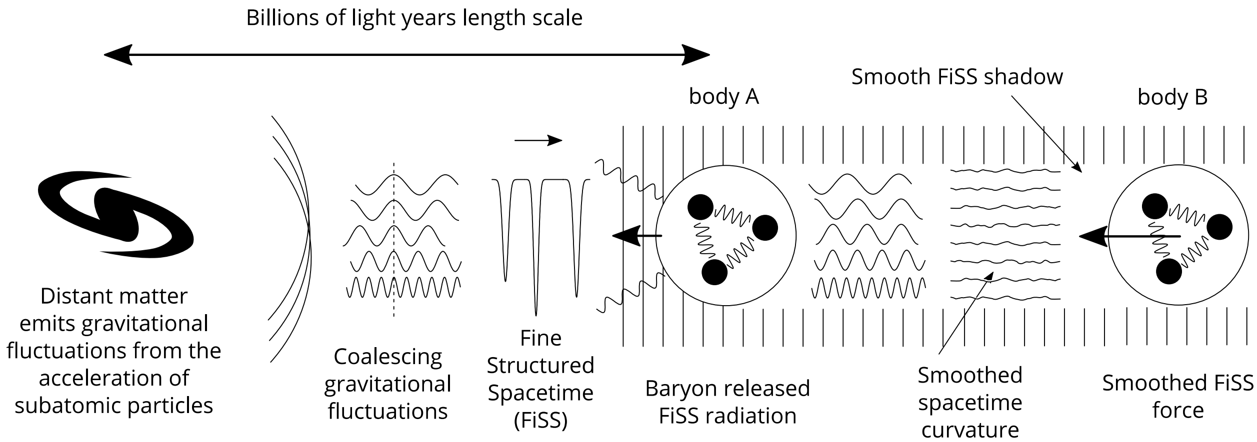


Figure 1: Shows hypothesized Fine Structured Spacetime (FiSS) from distant matter passing through a first body is scrambled into a smoothed spacetime curvature, which goes on to cast a smoothed spacetime shadow on a second body B, that now attracts normally to the distant matter. Proposed radiation ejected directly back out toward the distant matter from body A acts as a form of anti-gravity.

Regardless of the formation mechanism, it's then hypothesized these omnidirectional FiSS wave packets imprinted in the spacetime curvature, do not attract as normal smooth curved spacetime should when they arrive at body A, see Fig 1. Much like the inefficiency of water flowing down a rough surface or a ball bouncing down a set of stairs. It's proposed these high curvatures create disjointed and very sharp accelerations[6] of individual subatomic particles; quarks, nucleons, nuclei, and electrons, which we propose will radiate electromagnetic radiation and emanate their own gravitational potential in response. Furthermore, if the wave is localized in the x-y direction of travel, it will outright miss subatomic particles. FiSS waves can be viewed as a type by-pass transportation of the localized gravitational potential energy embedded in the spacetime curvature. These effects stunt long-range gravitation. But as FiSS wave packets travel through baryons, they are re-smooth (scrambled), see Fig 2c and as they travel further to body B (see Fig 1), the now Smoothed Fine Structured Spacetime (S-FiSS) curvature shadow pulls on body B as per the normal[7] GR prescription. The difference in both attractive forces we term the S-FiSS force. In a way, body A "screens" body B from FiSS wave packets. Since FiSS wave packets can

[6] Or in the General Relativity prescription, movements along sharply curved geodesics
[7] With a gravitational potential loss due to the new localized gravitational potential created and the FiSS radiation.

be considered as having very little beam divergence and little spread after smoothing interactions, the shadow S-FiSS could act on length scales of multiple galaxy separations.

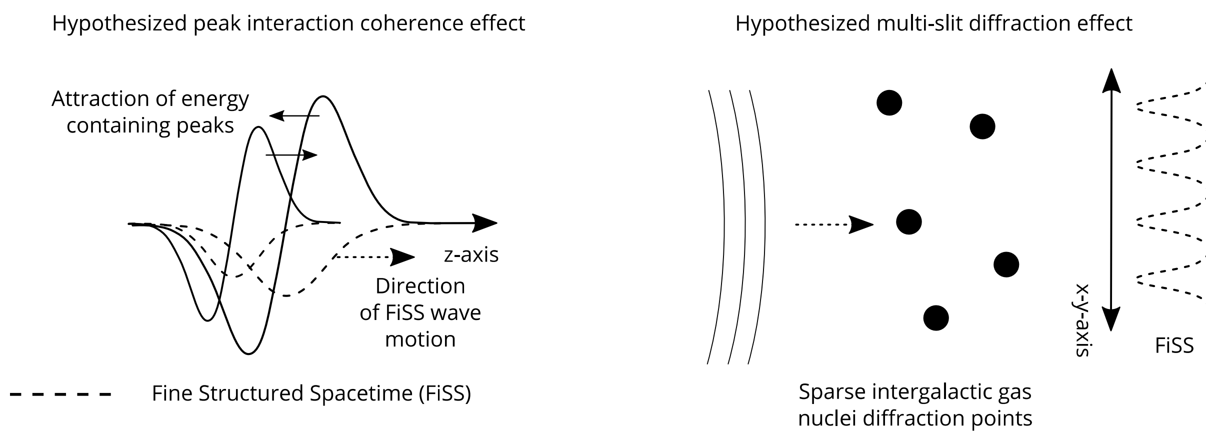


Figure 2a: Simplistic schematic showing attraction between the first derivative (localized energy holding) peaks of spacetime curvature fluctuations in the travel z-axis. Figure 2b: Showing an alternative or additional mechanism, where diffraction peaks build-up (somehow) via organized sparse intergalactic ionic gas and structure in the x-y direction perpendicular to the direction of travel. Note: the curvatures shown are small for graphical convenience; however, it's proposed FiSS involves extreme curvatures.

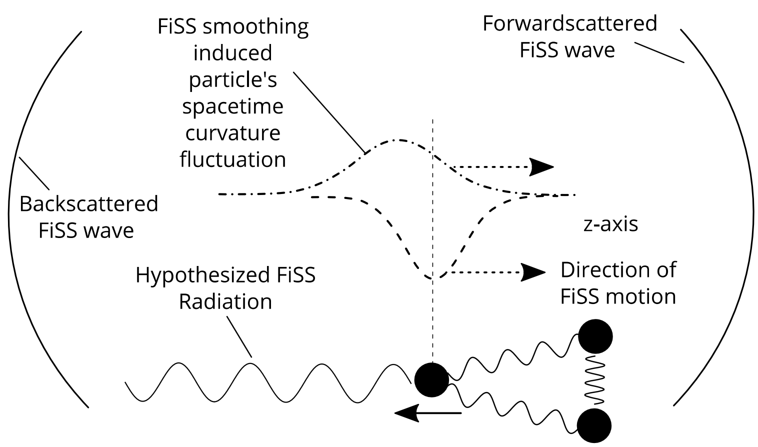


Figure 2c: Showing an example screening effect and re-smoothing of a FiSS wave via quark interaction. The elementary particle's sharp acceleration creates a spacetime curvature superposition that acts to broaden the FiSS wave going forward.

Fine structure in the spacetime curvature is not a new proposal, and there is evidence against any high curvature ripples in the form of experiments on ultra-cold neutrons.[15] [16] Here it was shown these ultra-cold neutrons lie on discrete levels exactly as predicted by the Schrödinger equation. At present, it's thought gravitation temperature is very low. However, we propose the screening mentioned above by our Milky Way's baryonic matter and, of course, the experimental housing itself, mostly prevents us from observing any such effects on Earth, as we are presently not far from the galactic plane in the center of our galaxy.[17]

Since an accepted quantum gravitation theory doesn't yet exist, and these effects are well within such a field, it's hard to theorize how these waves could have formed, the exact structure of the FiSS wave packet or its interactions with baryonic matter. However, we can further speculate, if we had a gravity wave detector that was sensitive enough to record the tiniest ripples in spacetime curvature fluctuations, in a well-shielded FiSS area like the center of a galaxy, what would we see if we took a fourier transform of such a signal? We hypothesis that we'd see peaks at frequency fluctuations corresponding to quarks, nucleons, nuclei, and electrons (and perhaps lower) – let's call these "flavors" of FISS. Hence we imagine FiSS would contain different size and width spacetime curvature packets, and perhaps these packets would only mostly affect their corresponding "flavor" subatomic particle. For example, an electron "flavor" FiSS wave could disjointly accelerate atoms in matter unevenly, but would not have much of an internal effect on a nucleus as it would accelerate the whole nucleus evenly. A nucleon/quark sized FiSS wave would disjointedly accelerate nucleons/quarks inside a nucleus (potentially facilitating radioactive decay) but may pass through the wavefunction of an electron without much effect. Hence we speculate that FiSS radiation is confined to different spectrum regions. Although, as sharper FiSS wave packets are downgraded and smoothed, it may be that the last unsmoothed remnants interact with electrons. For example, it would be tempting to ascribe these electron "flavor" FiSS interactions as partly the cause of the cosmic background microwave (CBM) signal, as this type of FiSS would be scattered and smoothed much more readily by ever-present hydrogen atoms and electrons in void space. Others have also put forward alternative suggestions for the CBM before.[18] But we would still have the issue of why it's so constant; perhaps, it's due to the concepts we shall put forth later (Fig 10), however, we digress for now.

Hence, we hypothesize an effect where long-range (universe scale) gravitation is suppressed (to what extent we don't know) and is turned into radiation first, but secondly, a localized spacetime curvature that seems to act very much like Dark Matter as we shall see soon.

We leave the subject of the exact nature of FiSS and its formation mechanisms to quantum gravity string/loop theorists, background independent quantum theorists and mathematicians alike. We want to further explore here what other force implications such a model might predict.

2.2 Backscatter FiSS and Frontscatter FiSS

Two further forces[8] are predicted to arise due to sharply accelerating subatomic particles in non-flat spacetime geometry. It's important to note, in the below discussions, we are always referring to **excess** forces resulting from FiSS on top of the existing unmodified GR gravitational force body A and B produce on each other. The first is Backscatter Fine Structured Spacetime (B-FiSS), and the second is Frontscatter Fine Structured Spacetime (F-FiSS). Both of these should fall off largely via an inverse square law; however, since they are directional, their strength and range will need to be fitted to galaxy observation data.

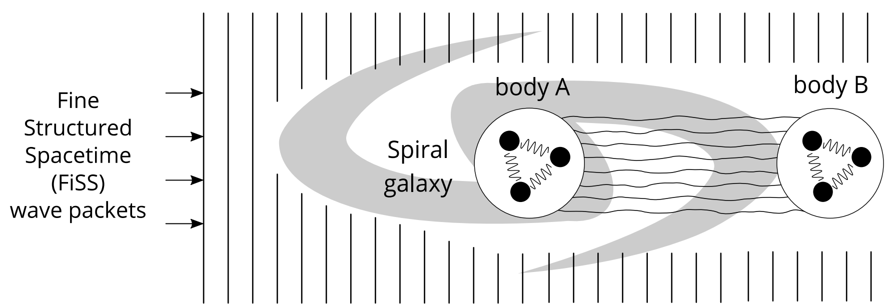


Figure 3, showing positional context for body A and body B within a galaxy as a guide for interpreting Figure 4 regarding Dark Matter mimicking.

[8] Note, in this work we use the term (gravitational) "force" interchangeably with the GR concept of spacetime curvature. Hence when we talk about an excess gravitational force we are of course referring to an extra curvature of spacetime.

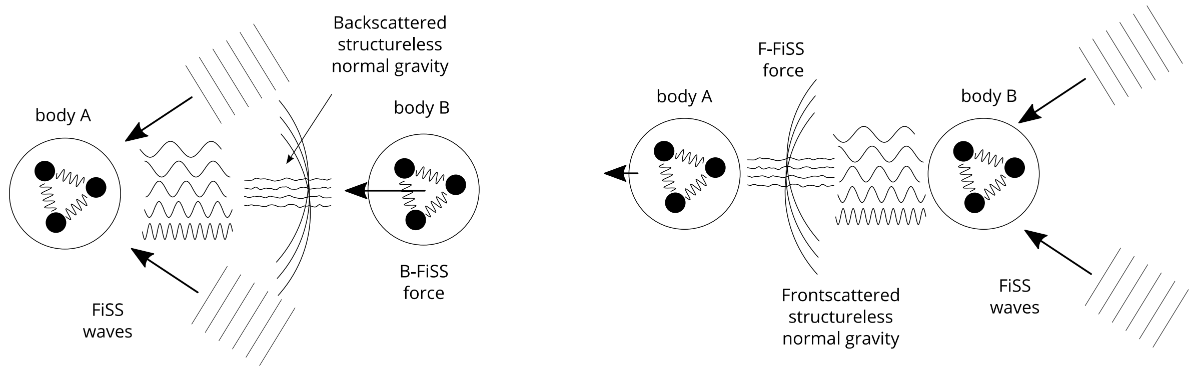


Figure 4a-b: Shows the proposed Backscatter FiSS force and Frontscatter FiSS force for a subatomic particle as an example.

Fig 4 should be viewed within the context of bodies within a galaxy, with locations shown in Fig 3, as we would like to discuss interesting effects the FiSS hypothesis has on galaxies with regards to its mimicking effect of Dark Matter.

Fig 4a shows a body A with a subatomic particle that is accelerated sharply toward a body B. It could be speculated from GR, body B will see an energetic (heavy: rest mass + large kinetic energy) particle momentarily appear, creating an extra hypothesized gravitational force. Of course, the subatomic particle from body A will pull other surrounding subatomic particles with it, and then itself get pulled back via standard model fundamental forces. We speculate this will create F-FiSS in the B-FiSS example, so the resultant force shown is proposed to be the average resultant excess gravitational force from the re-smoothing of FiSS wave packets.

For the F-FiSS force, see Fig 4b, a FiSS wave will create a sharp acceleration of body B subatomic particles away from body A. In this case it’s difficult to theorize as to the exact net direction of this force, however since body A and body B are gravitationally bound, and we are talking about an excess force, at present, it’s hypothesized body A may feel a small excess repulsion as a result. Both F-FiSS and B-FiSS potentially seem to imply a net form of anti-gravity. Two further effects can be hypothesized from our model.

2.3 FiSS Radiation Pressure Force

The pressure force on body A from the hypothesized FiSS radiation will depend on the flux and the nature of FiSS wave packets, how deeply FiSS penetrates a star's corona or a more solid object such as a dust particle, and the directional nature of any single interaction. If there is a large component reflected directly back out toward the distant matter, as there clearly should be, this would imply an anti-gravity effect. Quantum subatomic particle interactions in a highly curved, non-flat spacetime geometry would require a background-independent quantum theory - hence we can make no progress here - apart from our assumption that it should be directional.

2.5 The FiSS Model Within GR

We're unsure if this FiSS model could be integrated into GR without modification, and we leave this to others. Various conservation laws would need to be considered and balanced. However, it seems our model doesn't alter GR within our galaxy and our local solar system due to shielding, so it might have been difficult to detect. Various tests of GR near the earth should be relatively unaffected. Further, the propagation of massless elementary particles in S-FiSS curvature should not differ from FiSS. Afterall, FiSS is merely a rippled spacetime curvature; light waves should travel through these ripples and, on average, be curved in the same way as if it were smooth spacetime curvature (we assume). It's only the extra B-FiSS curvature that is hypothesized to affect the geodesic curves of photons, and that's a relatively short-range force, felt outside of our shielded galaxy, so again it might not have been detected.

3. Defining the Proposed FiSS Forces

Here we define the FiSS forces from a Newtonian viewpoint to facilitate computational simulations and as a convenient means to illustrate the forces proposed. However, it must be stressed FiSS purely is a spacetime curvature GR type effect.

3.1 S-FiSS Force (non-relativistic) and MOND

As mentioned in the introduction MOND is quite successful at predicting a large range of galaxy rotation phenomena. Any proposed theory should reproduce this empirical observational-based law, providing theoretical and physical underpinnings. Furthermore, the theory should fix MOND's shortcomings and/or explain the physical basis for MONDs transition function.

To make calculations simpler, for now, we make the following assumptions:

1) We assume FiSS wave packets arrive omnidirectionally at each point around our model galaxy, have no beam divergence and have a small spread after smoothing interactions (which will need to be fitted), but no complex edge diffraction effects.
2) We ignore forces from B-FiSS and F-FiSS as too small in the outer regions.
3) We assume complete FiSS filtering efficiency for any stellar body within an inner diameter *d*, and 0 outside of this diameter.

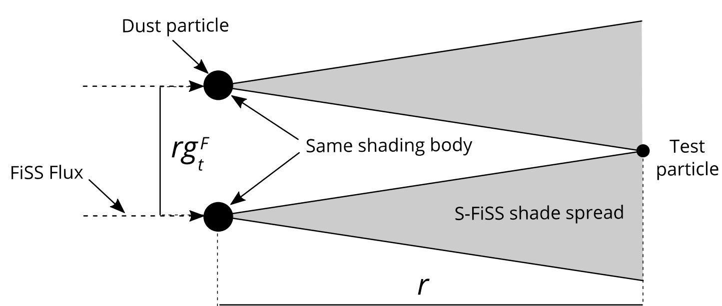


Figure 5, showing FiSS flux that would have otherwise missed the test particle if there was no spread in the S-FiSS shadow - is now shown hitting the test particle due to spread. Note: the above diagram shows the same dust particle. The dust particle hence has a larger projected area. The spread constants g_t^F are dependent on the *type* of body in question. For example, a star will have a different spread constant compared to dust or gas-particle and need to be fitted to data from galaxies with differing amounts of each.

In the far limit for a test particle situated at a distance *r*, very far from a galaxy, where we can largely ignore the vector directions from each body, in our simple model we define the force on our test particle as;

$$F_{test} \propto \Phi_{\text{FiSS}} \sum_{l=1}^{k} S(r_l)\delta_l{}^2\, d_l{}^2 \qquad \text{Eq 1}$$

where Φ_{FiSS}, is the FiSS flux surrounding our model galaxy, $S(r_l) = 1 + g_t^F r_l$ is a FiSS projected area spread function (see Fig 5), with spread constants g_t^F (which are different for each *type* of body), d_l is the diameter of body l, and δ_l is the apparent size of the body at r_l, from the test particle. The sum is over all bodies k in our model galaxy.

So we have,

$$F_{test} \propto \sum_{l=1}^{k} \delta_l{}^2 d_l{}^2 + g_F r_l \delta_l{}^2 d_l{}^2 \propto \sum_{l=1}^{k} d_l{}^4/r_l{}^2 + g_t^F d_l{}^4/r_l \propto \sum_{l=1}^{k} d_l{}^4/r_l \qquad \text{Eq 2}$$

Where we used, $\delta_l = 2\arctan\,(d_l/2r_l) \approx d_l/r_l$, and ignored the small $d_l{}^4/r_l{}^2$ term for all $r_l \gg d_l$. Hence we have a first MOND result, namely, that $F \propto 1/r$, instead of r^2.

If we assume all bodies in our model galaxy are the same diameter, and basically at the same r_l from the test particle,[9] we have

$$a_{test} \propto\; V_{test}(r)^2/r \propto kd^4/r \qquad \text{Eq 3}$$

If we naively assume the density of all the bodies is the same and constant throughout,[10] i.e., has no relationship to mass, so that $\propto \sqrt[3]{m}$, where m is the mass of the body, we have

$$V_{test}{}^2 \propto km^{4/3} \qquad \text{Eq 4}$$

A linear baryonic Tully–Fisher relationship with a slope of 2. We can review a couple of assumptions in this context.

Firstly, we have thus far we've assumed no stellar body overlap, i.e., no two bodies are collinear with the test particle. Any such overlap will increase the gradient in the FiSS Tully–Fisher relationship chart because we can add a large mass and simply hide it on the other side of the galaxy behind a body inline with the test particle's view, hence the particle's F_{test}, stays constant in the FiSS area projection model. If we assume the number of such bodies that "don't count" has an exponential relationship with the concentration of bodies present in the galaxy we have:

$$V_{test}{}^2 \propto k^x m^{4/3} \qquad \text{Eq 5}$$

[9] Since the majority of bodies are near the center.
[10] A fair assumption for dust particles, but not so for stars where the density would have a complex dependence on mass.

where the exponent x has a complex dependence on the concentration and size of the bodies in the galaxy. If we consider the cross-sectional area of a single star, the diameter of an average galaxy, and the total amount of stars in that galaxy, it's very clear the probability of even a single overlap is minuscule. Hence FiSS predicts for a star diffuse, gasless, and dustless galaxy, with little chance of overlap, i.e., $x \approx 1$, a Tully–Fisher slope of around 2, while a galaxy dominated by (complex) gas and dust with $x < 1$ would have a higher slope. A spread of Tully–Fisher slopes is consistent with the literature, typically[9] centered around ~4, but with some reporting slopes as low as 2.64.[19] Hence, we conclude that the more numerous dust and gas particles and a very small spread in S-FiSS, must play a large role in galaxy rotation curves. All this will need to be modeled properly and fitted to data. This is consistent with Fig 2 in Famaey *et. al.*[9]

This picture also explains why ultra-diffuse galaxies (UDGs) - where the baryonic mass is dominated by only HI gas - lie off to the left of the baryonic Tully-Fisher relationship as found in a recent study.[20] Namely, these galaxies are devoid of a high concentration of more complex baryonic matter required to interact and smooth FiSS waves. HI atoms contain only a single proton and single electron; hence there are no chemical bonds, no nuclear binding bonds between nucleons in a complex nucleus, just the strong force acting between the three quarks in a single proton.

On the other hand, a recent study at the other extreme, i.e., super spirals by Ogle *et al.*[21] showed these galaxies lie to the right of the baryonic Tully-Fisher relationship (Fig 2), in the worst case having rotation speeds 10% too high. This is inconsistent with the above reasoning, which would predict an x exponent with would probably be less than ½ for such super spirals. It was speculated that for these observations to be consistent with MOND there would need to be missing baryonic matter inside the "radii probed by our rotation curves." This may yet be the case, but FiSS would provide a further, more straightforward explanation; from an analysis of these types of galaxies, it was postulated "super spirals did not form at the cluster center of mass, but rather in the outskirts." [22] If that's the case, such galaxies would simply be exposed to a larger FiSS flux, instead of being partly sheltered in the center of a supercluster; this systematic error could easily explain a mear 10% increase in rotational speeds for such galaxies. This supposition seems to be further backed by Rodrigues, *et al*.,[23] which found MOND a_0 accelerations of various galaxies have a spread of approximately 15% from highest to lowest. This is suggestive of the concept that different galaxies are exposed to varying levels of FiSS flux depending on how sheltered they are by surrounding galaxies. See below for a discussion on FiSS sheltering/screening.

While hardly a proof, it can be seen that FiSS is very promising in being able to reproduce and explain the nature of the Tully–Fisher relationships, however, a full computer simulation including all forces, normal gravity, B-FiSS, F-FiSS, and FiSS radiation will be required to confirm.

Due to the above initial assumptions involving very little spread in FiSS, we predict that two (reasonably large) galaxies, multiple average galaxy-to-galaxy separations apart - on the order of 10^{+2} Mpc - should still feel at least some of this force. However, this will need to be fitted to data. It's anticipated that at some point, the S-FiSS shadow, going through voids will "re-structure" reverting to FiSS. Its spread and the smoothing effect discussed in Fig 2c, will also weaken it on those scales. If FiSS is readily formed over a shorter range, in local voids say, then the beam divergence and S-FiSS spread after smoothing should weaken this force over say 10Mpc distances.

3.2 Backscatter FiSS and Frontscatter FiSS

The B-FiSS is a more complex force, and we can only make minor progress here, just generally describing what we envisage B-FiSS to be. We start with Fig 6a which shows how we firstly define $\boldsymbol{P}_n[f_s(r_0, \theta, \varphi)]$ a vector projection screening function for the total remaining FiSS flux experienced by subatomic particle y at point n inside or on the body's surface from all directions at a certain point in time. Note: $\boldsymbol{P}_n$ has no r dependence, it's dependant on the value of f_s at r_0, as it doesn't matter where the flux was filtered (we've assumed the S-FiSS spread described above wouldn't produce much B-FiSS).

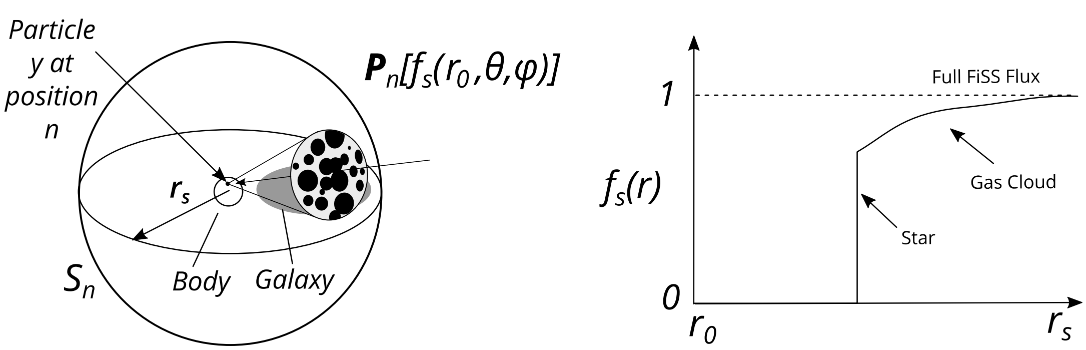


Figure 6a: showing $\boldsymbol{P}_n[f_s(r_0, \theta, \varphi)]$ a vector projection screening function for the total remaining FiSS flux experienced by subatomic particle y at point n inside or on the body's surface. Figure 6b: shows an example screened flux function $f_s(r)$ for illustrative purposes.

Fig 6a shows an example screened flux function $f_s(r)$, i.e., the remaining FiSS flux observed by subatomic particle *y* at point *n*, going through all baryon matter out to the imaginary sphere S_n, encompassing the entire galaxy.

How fast the screening function $f_s(r)$ is attenuated by diffuse and dense stellar matter, will have to be fitted, as we don't have an interaction theory. However, black holes and neutron stars could be ignored due to their small cross-sectional areas. Bright and dark baryonic matter, such as stars, planets, etc… down to rocks and dust are expected to filter FiSS very efficiently. Gas is also expected to filter FiSS but by unknown amounts. Interactions of FiSS with ionized gas is almost completely unknown, but from the evidence described below, it almost seems like ionized gases could be involved in promoting the formation of FiSS as opposed to smoothing them. It should be clear that the physical basis for the MONDs transition function is this screening effect.

The amount of B-FiSS and F-FiSS producing FiSS wave packets arriving at point *n* for particle *y*, inside or on a body's surface, for a body inside a galaxy, from the direction $\boldsymbol{P}_n$ would be,

$$\Phi_{\mathrm{FiSS}}\boldsymbol{P}_n[f_s(r_0,\theta,\varphi)] \qquad \text{Eq 6}$$

Where Φ_{FiSS}, is the FiSS flux in the particular region in question,[11] determined by the amount of gas, dust, and galaxies in that particular galaxy cluster.

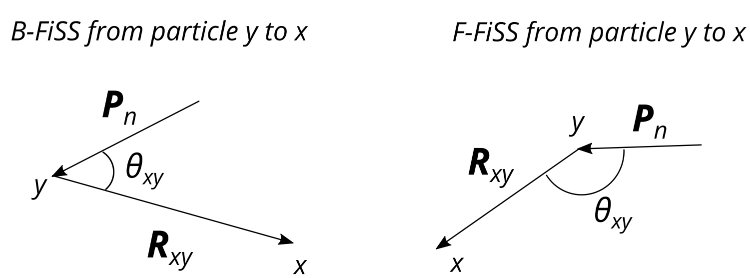


Figure 7: showing vector directions for $\boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]$ a vector projection screening function for subatomic particle *y*, producing B-FiSS and F-FiSS for subatomic particle *x*. $\boldsymbol{R}_{xy}$ is the vector from subatomic particle *y* to *x*, and θ_{xy} is the angle between *y* and *x*.

[11] Technically, this should also be directional.

If we were to guess at a Newtonian functional form for the B-FiSS force, $\boldsymbol{F}_{xy}^{B}$, produced from a FiSS flux direction defined by $\boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]$ see Fig 7, the B-FiSS force acting on subatomic particle *x* backscattered from subatomic particle *y* would be:

$$\boldsymbol{F}_{xy}^{B} \propto -\Phi_{\mathrm{FiSS}}\Theta_{\mathrm{B}}\frac{\widehat{\boldsymbol{R}}_{xy}\ .\ \boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]}{|\boldsymbol{R}_{xy}|^{e_B}}\widehat{\boldsymbol{R}}_{xy} \quad \text{for } \cos(\theta_{xy}) > 0 \qquad \text{Eq 7}$$

Where Θ_{B} is the B-FiSS gravitational constant, e_B is the B-FiSS exponent, which we would guess would be close to ~2. Both these constants will need to be fitted. $\widehat{\boldsymbol{R}}_{xy}$ and $|\boldsymbol{R}_{xy}|$ is the unit vector and distance from subatomic particle *y* to *x*, and θ_{xy} is the angle between *y* and *x*, with the force being defined only for $\cos(\theta_{xy}) > 0$. For $\cos(\theta_{xy}) < 0$, we have the weaker F-FiSS:

$$\boldsymbol{F}_{xy}^{F} \propto -\Phi_{\mathrm{FiSS}}\Theta_{\mathrm{F}}\frac{\widehat{\boldsymbol{R}}_{xy}\ .\ \boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]}{|\boldsymbol{R}_{xy}|^{e_F}}\widehat{\boldsymbol{R}}_{xy} \quad \text{for } \cos(\theta_{xy}) < 0 \qquad \text{Eq 8}$$

Where Θ_{F} is the F-FiSS gravitational constant, e_F is the F-FiSS exponent, again both will need to be fitted.

However, this is far as we can go, as ultimately, FiSS is not a Newtonian gravitational hypothesis; we cast it in a Newtonian framework merely as an illustration. It should be clear the deeper we go into the galaxy, the more the B-FiSS production will fall off as $\boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]$ goes to zero for most subatomic particles. B-FiSS would appear very much like Dark Matter, a locally produced (scattered) form of extra gravitation, producing what would seem like a mass halo effect around a galaxy. Interestingly, it can be argued that it's impossible for $\boldsymbol{P}_n[f_s(r_0,\theta,\varphi)]$ to be completely zero within our solar system, due to the overlap argument given above, even for dust and gases some FiSS flux must get through, we speculate this may be the cause of the intermittent fly-by anomaly.

The exact functional form of B-FiSS is very difficult for us to guess at, as we don't know the FiSS waveform or scatter mechanism or how the scattered waves would interact with surrounding subatomic particles, which would themselves produce scattered waves - and what total effect that would have on the end B-FiSS force emanating from a body. Such treatment is well within a non-flat curvature quantum gravity theory. As stated, we assume the net force should fall off as an inverse square law; however, given its directional nature, this may not be the case.

What we envisage clearly, though, is that the B-FiSS force would be much greater than the F-FiSS force. Comparing to S-FiSS, from a conservation of forces argument, and also from McCulloch *et.al* [24] who calculated the predicted MOND velocity dispersions of various dwarf galaxies, and compared these values to the actual observed values, it’s clear that the missing force in the MOND model; B-FiSS is of the same order of magnitude as S-FiSS. For computer simulations of galaxies, a functional form for these forces could be guessed at, with various fitting constants.

3.3 Summary of Forces for the FiSS Framework

To summarize all the forces proposed.

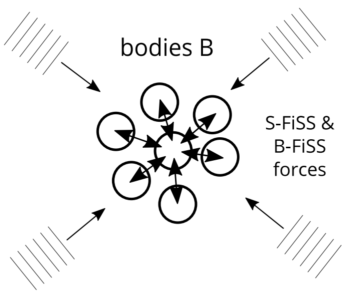
Hypothesized FiSS Force	Hypothesized Magnitude	Hypothesized Direction and Distance Behaviour
S-FiSS	Near equivalent to MONDs a_o	Attractive and falls off as $1/r$ from smoothing source, acts toward incoming FiSS flux
B-FiSS	Similar magnitude to S-FiSS	Attractive and falls off as $1/r^{\sim 2}$ from smoothing source, acts away from the incoming FiSS flux
F-FiSS	Much weaker than B-FiSS, yet still within the same magnitude	Repulsive and falls off as $1/r^{\sim 2}$ from smoothing source, acts away from the incoming FiSS flux
FiSS Radiation Pressure	Approximately the same order of magnitude required to produce the anti-gravity effect needed to balance the second Friedmann equation	Radiative impulse force pushes a body away from incoming FiSS flux.

Table 1. Summary of all the hypothesized FiSS forces, their magnitude, direction nature, and distance behavior, however conservation of energy laws will need to be carefully considered.

4. Possible Consequences of FiSS Forces for Cosmological Structures

From thought experiments, several structures are naturally stabilized by FiSS forces that seem to appear often in the cosmos and are explained by invoking Dark Matter effects. Firstly, Fig 8a shows the cross-section of a long cylinder of stellar-mass bodies in space that is non-rotating, the S-FiSS and B-FiSS force created by FiSS coming in around the cylinder will act to compress the cylinder.

Secondly, we imagine the line of structures that are stretched out (which may or may not be strongly gravitationally bound by the normal inverse-square law), but this time viewed along the length, so we have a line of bodies as shown in Fig 8b. A body B shown moving out of line will get exposed to a much larger cross-sectional area screening of FiSS from both sides, hence there is an S-FiSS force pulling the body back into line. We think these long-distance forces naturally stabilize thread-like structures often seen in the "cosmic web."



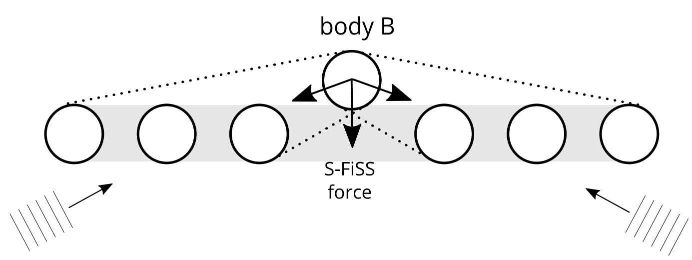


Figure 8a: Showing the cross-section of a non-rotating elongated like gravitationally bound structure in space exposed to radial FiSS. The figure also shows the envisaged S-FiSS and shorter-range B-FiSS forces on particles inside the cylinder. Figure 8b: Shows a line of bodies that are only very weakly gravitationally bound with a single body out of line. The figure shows how an increase in the projected shielding fraction of FiSS would result in an S-FiSS forced pulling the body back into the structure.

Now again we imagine a line of bodies (Fig 9a) but this time more dense and closer together within the shorter range (near inverse square law) of the B-FiSS force. Here, sections of the line at higher densities will tend to clump together strongly, with the F-FiSS force contributing to the clumping effect, forming nodes within the line. At the end of the line, a body A that moves out of line will get exposed to a much larger cross-sectional area FiSS screening function. However, this time from one side, so it's predicted both the S-FiSS force and B-FiSS (and normal GR gravity) will pull on this straggler, which would tend to clump the ends of line structures. This effect predicts the formation of dumbbells for isolated line structures within the FiSS framework.

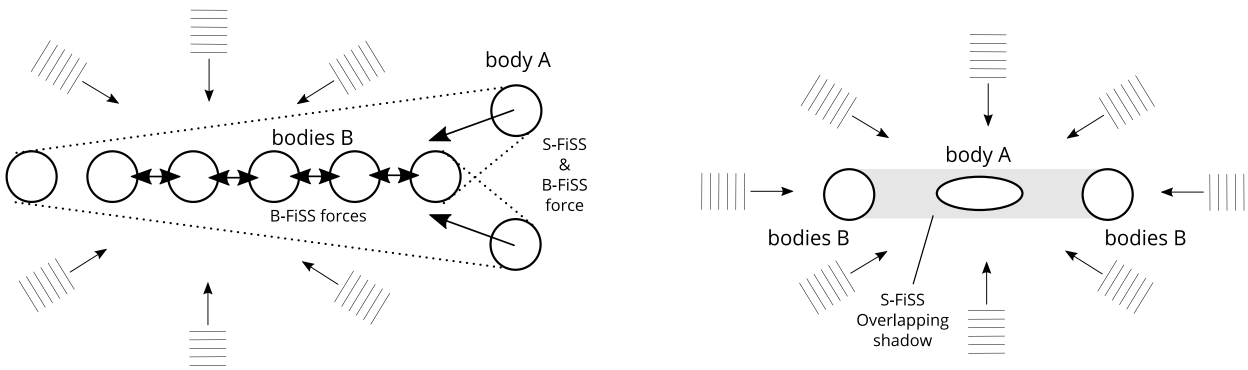


Figure 9a: shows a gravitationally bound line of bodies, short-range enough for the proposed B-FiSS forces to be significant; this is hypothesized to result in an extra clumping effect, especially on the ends, which would imply dumbbell formation. Figure 9b: shows three galaxies only very loosely bound by normal inverse square law gravitation, but aligned such that body A, resides in the overlapping S-FiSS shadows created by bodies B. Body A is predicted to exhibit unusual tidal forces from the missing S-FiSS and B-FiSS components collinear with the bodies.

Fig 9b shows a strange and interesting prediction for FiSS. For a line of bodies only very loosely bound by normal inverse square law gravitation, but aligned such that body A, resides in the overlapping S-FiSS shadows created by bodies B. Body A is predicted to exhibit unusual tidal forces from the missing S-FiSS and B-FiSS components. Body A should also experience an S-FiSS minimum potential well inside the shadow. This tidal effect could explain elongated elliptical galaxies,[12] so it would be interesting to see if elliptical galaxies have flanking galaxies on either side.

5. Possible Consequences for Looking Out from the Milky Way

[12] Including the rather strange square dwarf galaxy, LEDA 074886, which could be in a double S-FiSS cross shadow, i.e., with four surrounding large galaxies orbiting it.

Depending on how strong and directionally dependent FiSS radiation and B-FiSS forces are, these effects could have major consequences on the Hubble constant calculation and our view of the outside universe, if FiSS is real. Presently there is a discrepancy in the Hubble constant beyond estimated errors, termed “the cosmological crisis” where Hubble constant measurements using standard candles seem to be larger than the CMB measurements. If FiSS radiation is true and some part of it is in the visible band, we may not see as much directly reflected FiSS radiation from nearby galaxies, due to our galaxy shielding FiSS wave packets with a direct line of sight to the galaxy.[13] Hence less direct FiSS radiation would be produced that would be reflected back to us, see Fig 10b. In the Hubble diagram, if we would remove this extra light from distant galaxies they would hence be further away which would flatten the Hubble diagram and perhaps nudge the Hubble constant measurement closer to CMB measurements from the European Space Agency's (ESA) Planck satellite of 67.4 km/s/Mpc.

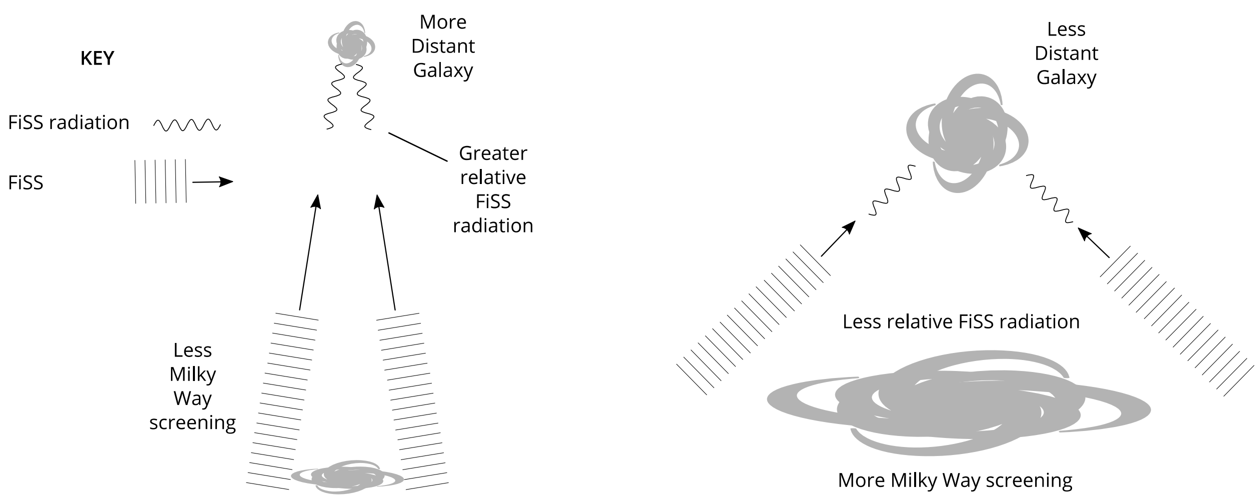


Figure 10a: Shows the Milky Way providing less FiSS wave screening for distant galaxies, which would make them appear relatively brighter (as compared to Fig 10b). Figure 10b: Shows the Milky Way screening a large nearby galaxy. This is hypothesized to make the galaxy seem less bright than Fig 10a. B-FiSS and red-shift for galaxies with transverse velocity will need to be considered.

One further important possible consequence, the relative traverse motion of a galaxy with respect to our Milky Way, could affect the amount of FiSS radiation (and B-FiSS) directed back to us. The greater the

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[13] Note, since FiSS is assumed to be coming in from all directions, our galaxy should cast an FiSS smoothed shadow on every near observable object, no matter it's peculiar or rational velocity because it's always possible to trace a gravitation wave hitting the object in question back in time to that same wave going though our galaxy at the exact direction require to hit that object. For very distant objects the FiSS shade our galaxy casts on it will be quite diffuse; further, FiSS is of course anticipated to re-structure going through voids.

traverse motion the more likely our Milky Way galaxy moves into or out of FiSS radiation depending on the relative motion and distance between both bodies.

All these effects would also have consequences for the fluctuations seen in the CMB measurements, as this light passes through various galaxies over the age of the universe.

6. Evidence for and Against FiSS as an Explanation for Dark Matter

So we've shown how the hypothetical long-range S-FiSS force could reproduce MOND which itself is very successful in reproducing several observations, replacing the need for Dark Matter; these points are summarized from Famaey *et. al*.[9] here, and further discussed from a FiSS perspective:

The bulk flow challenge – the S-FiSS force by its nature is predicted to be very long-range (as discussed) pulling galaxies together, which might explain the extra peculiar velocities not predicted by the ΛCDM model.

The high-z clusters challenge - structure formation is happening earlier than ΛCDM models predict. Again the extra long-range forces predicted by S-FiSS and B-FiSS could help explain this, however, computer simulations would be required.

The Local Void challenge - as described in Fig 2a, B-FiSS is predicted to strongly pull nodes and straggling bodies toward centers of baryonic mass, which could help explain the formation of voids. Secondly, if voids are helping to create FiSS wave packets, the inner surface of a void (wall of first contact galaxies and filaments defining the inside of the void's boundary) could be emitting FISS radiation directly back out into the center of the void; pushing this wall back and hence opening the void further, which could explain the spherical nature of voids.

The missing satellites challenge & satellites phase-space correlation challenge – it's too difficult to mentally visualize FiSS forces and their effects on satellite galaxies to say conclusively if FiSS could explain these, this would require computer simulations. However, for an orbit with an orbital axis that's parallel with the plane of the galaxy, FiSS predicts a strange unstable and varying orbital force around the galaxy, where a large inward pull is predicted when particles are directly above the disk, i.e., facing maximum screening of FiSS and less when the particle is in-line with the plane of the disk, i.e., minimum screening of FiSS.

The angular momentum challenge - if FiSS reduces or replaces Dark Matter, there is no transfer of angular momentum.

The pure disk challenge - large bulgeless thin disk galaxies are difficult to produce in ΛCDM simulations due to the frequency of mergers and the time required for them to form in the ΛCDM model. However, from the extra forces shown in Fig 8, very flat disks are predicted by FiSS.

The stability challenge - Large diffuse Dark Matter halos are proposed to reproduce very low surface density disks (LSDD) however, this leads to a failure to show bars and spirals. In contrast, LSDD with these structures are observed. Further, this lack of disk self-gravity prevents large-thin LSDD, while these are also observed. S-FiSS provides the force required to flatten disk structures, while B-FiSS provides the short-range force to form spirals and stabilize barred structures in diffuse galaxies. Computer simulations would be required.

6.1 Challenges to MOND - can FiSS explain them?

MOND still needs Dark Matter – for dwarf galaxies. However, FiSS predicts the extra B-FiSS force and the FiSS radiation force. The B-FiSS force should be maximally produced for galaxies with a clear outer region which allows FiSS to penetrate deep into a dense core – that is dense enough to filter the majority of FiSS and convert it to scattered B-FiSS.

The colliding "Bullet Cluster" galaxy - is commonly cited as evidence against modified gravity theories,[25] and forms a good test. While FiSS and S-FiSS are not envisaged to affect light differently, since logically both are just different spacetime curvature waveforms[14] - the B-FiSS generated spacetime curvature should bend light. Hence we predict FiSS coming into the sides of the emerging galaxies (stripped of gas) would create sharp B-FiSS curving lensing effects. It's argued 90% of the baryonic matter is in the middle gas and hence any alternative gravity theories should account for why the bulk of the gravitational lensing is taking place for the non-gaseous baryonic matter emerging on both sides. However, the B-FiSS effect would be quite weak and spread out for such a diffuse gas and may show little sharp lensing effects. Further, since the gas is thought to be ionized, much less B-FiSS gravitation would be produced due to the much reduced cross-sectional area of the screening gas particles.

[14] Unless the previously mentioned, formation of self-cohesive quantized FiSS waves effects light differently.

MOND needs different values of a_0 - as shown by Rodrigues, *et al*.[23] there is no one single a_0. FiSS, on the other hand, does not predict a single a_0. In Equ 6 above, it should be clear that Φ_{FiSS}, the FiSS flux - which can be related to MOND's a_0 - is dependent on the nature and amount of baryonic matter surrounding and shielding a galaxy in question, hence FiSS predicts a varied MOND a_0.

6.2 Spiral Arms and Barred Galaxies

Presently, it's not fully understood how spirals form and perhaps why barred structures in galaxies are so stable, especially in low-density spirals. Spiral arm formation via the proposed density wave theory[26] [27] would require an unknown gravitational force acting in local regions within the disk, creating localized compression of galaxy disk contents. FiSS naturally provides several such forces through the short-range B-FiSS force, see Fig 2a, and through limited penetration of FiSS into spiral arms from the sides of the disk, and lastly through a relativistic effect where S-FiSS wouldn't produce a force toward the center of the disk, but slightly off-center shifted toward the incoming spiral arms, due to the amount of time it takes S-FiSS waves to travel across the galaxy. There is also Renzo's rule[28] "for any feature in the luminosity profile, there is a corresponding feature in the rotation curve, and vice versa." Looking at this from a FiSS perspective certainly, a test particle in front of a spiral arm facing the galactic center with the spiral arm body at it's back will feel less S-FiSS toward the center, because S-FiSS projections as well as short-range B-FiSS forces, from the close by spiral arm at its rear, is pulling it back. It's difficult to visualize these effects and computer simulations will be required – we believe FiSS forces could help explain the formation of spiral arms.

Regarding barred galaxies, all the effects shown in Fig 8 and Fig 9 would seemingly stabilize a dumbbell-like cylindrical structure within the center of the galaxy, i.e., three main mass centers in a collinear arrangement. Something akin to two balls and chain spinning around a center, however, we still have a "winding problem," and it should still be curved at least to a degree, but it seems some bars are perfectly straight. Here the strange predicted effect of FiSS could be in play, as shown in Fig 9b, which details the stabilization and elongation of a galaxy that resides in a FiSS cross shadow potential well cast by two galaxies. Further, we wonder if barred galaxies are stabilized by two rotating large satellite galaxies collinear with the bar in a stable outer orbit around the galaxy. Computer simulations will need to confirm.

Further, it's also observed galaxies in the distant past have disordered spirals, whereas today's galaxies have well-defined arms. If FiSS explains spiral arms, we can point out that by its very nature, FiSS would need time and vast tracks of void space to form and perhaps a specific concentration of intergalactic ionic gas in these voids via the above-mentioned interference diffraction mechanism. Hence this seems consistent if FiSS forces were not as strong in the early universe.

6.3 Subhalos

The interruption and gap formation in streams that surrounds our Milky Way galaxy is not well understood. To explain this, researchers[29] have introduced Dark Matter subhalos that punch holes through these streams, however clumping through the shorter range B-FiSS and repulsive F-FiSS forces, arising from any density inhomogeneities in these streams, especially for objects exposed to full FiSS flux outside of our galaxy, is predicted, see Fig 9a. What we can't see, however, is how it could explain the doubling of streams that are sometimes observed, called "spurs." These are thought to be explained via a collision with a large Dark Subhalo object. This will require computer simulations.

6.4 Wide Binaries

Hernandez *et. al.* have looked at a couple of catalogs of wide binaries[30] [31] and found evidence of MOND like behavior and a breakdown of Kepler's third law. For Dark Matter to explain this we'd need localized miniature halos around the binaries. However, FiSS could explain this and the scatter in the data. Wide binaries could be bound by the B-FiSS forces if they are exposed to a strong FiSS flux outside the disk. But there would be a large scatter in the data as some wide or mid-range binaries are located deeper inside the disk, and would only experience partly shielded FiSS.

6.5 Jellyfish Galaxy

The jellyfish galaxy ESO 137-001 in the constellation Triangulum Australe, has streams of gas bleeding off the disk produced by ram pressure stripping. The streams of gas are thread-like and have condensed to the point of forming stars. It's poorly understood why stars should be forming in these streams of hot gas given their temperature.

From a FiSS perspective, however, the trailing gas steams are now fully exposed to a larger FiSS flux outside the galaxy. S-FiSS and B-FiSS forces would provide the extra gravitational forces needed to collapse these gases to form stars.

6.6 Dwarf Galaxy NGC1052-DF2

Recently, it has been shown that location is important to consider when looking at rotational curves. It was argued that MOND was invalidated because the internal motions were too slow within this galaxy. However, Krupta *et. al.*[32] argued that motions within dwarf galaxies would be slower if close to a massive galaxy. This is what FiSS predicts due to the concept of FiSS shielding near a galaxy.

6.7 Ultra-Diffuse Galaxies Missing Dark Matter

Ultra-Diffuse Galaxy NGC 1052-DF2 is spherical, as large as our Milky Way but with 200 times fewer stars, and seemingly with missing Dark Matter. Basically, you can see right through these galaxies. FiSS could explain these galaxies, firstly from Equ 3 larger FiSS forces would arise only if there is sufficient apparent projected matter screening. Diffuse galaxies that are perhaps gas/dust-poor would not produce strong FiSS forces; hence it would seem like there are little Dark Matter effects in them. B-FiSS forces would be small as they are too short-range and not produced in sufficient amounts for such a diffuse galaxy.

Further, the galaxy neighborhood must be taken into consideration; FiSS predicts that there would be less Dark Matter effects if galaxies are surrounded by other large galaxies that are very close by due to FiSS screening. Or, as we shall see next if there are significantly large dark baryonic spiral arms that are yet to be discovered that are shielding the inner core from FiSS.

6.8 Case of Galaxy UGC 1382

Originally thought to be a simple elliptical galaxy, with Newtonian dynamics, it turned out that the galaxy had large spiral arms with a far-reaching low-density hydrogen gas disk when astronomers incorporated ultraviolet and deep optical data.

The elliptical cores rotating at Newtonian dynamics would be largely shielded by the newly discovered arms. MOND would say the acceleration of the elliptical core is Newtonian because it's above the low acceleration range, and would apply the transition function. However, FiSS seems to suggest a much more physical explanation; namely, the core is well shielded from FiSS coming from around in plane of the disk.

6.9 Case of Antlia 2

Antlia 2 is a large Milky Way dwarf galaxy with the lowest surface brightness seen to date, "100 times more diffuse than the so-called ultra-diffuse galaxies"[33] with a very low velocity dispersion valve of ~5.7km/s. Due to its unusual characteristics, it forms a good test for alternative gravity theories, and indeed Dark Matter. "Antlia 2 inhabits one of the least dense Dark Matter (DM) halos probed to date… "may even require alternatives to cold Dark Matter … such as ultra-light bosons" [33]. At present, it's not understood why and how it is so diffuse.

Viewing the galaxy from a FiSS perspective, firstly, it may be that this large galaxy is experiencing a FiSS shading effect from the Milky Way as described in Fig 10b, hence it may not be so dim or far away and hence diffuse at all. However, it still has a low-velocity dispersion, which could be explained by FiSS from Eqn 1. Namely, there is very little S-FiSS force (and apparent Dark Matter) due to the galaxy's diffuse nature, as long as the galaxy also has little matter in its core.

6.10 Milky Way Gas Halo

Gupta *et. al.*[34] show evidence of a massive halo of hot ionized gas surrounding the Milky Way. Consistent with the trend - as discussed in the topic "Case of Galaxy UGC 1382" - we keep finding dark baryonic matter as telescopes and techniques become more refined, and the trend will no doubt continue. The observation of significant baryonic matter (same weight as the Milky Way) surrounding the Milky Way, assuming our galaxy is not unique, would tend to invalidate FiSS, (since gas filters FiSS waves) if not for the fact that this gas is ionized and is very diffuse. Ionized gases would provide a much smaller cross-sectional area in screening FiSS and would not "see" much of the gravitational effects of "Dark Matter." A unique prediction of FiSS (Eqn 1) is that the S-FiSS force a body experiences is dependent on the body's density, i.e. cross-sectional area.

6.11 Dark Matter Heating – Cuspy Problem

It was observed older, less-active galaxies tended to have Dark Matter cusps while more active gas-rich galaxies tended to have flat cores. This naturally arises in FiSS, due to different penetrative depths into a galaxy. Hence less-active older galaxies would have had time to use up their gases (and/or had them stripped at some point in their history). Stars and dark baryon objects formed in such galaxies would have had more time to settle into a denser core. A "cleaner" outer region would allow FiSS to penetrate deeper into the galaxy's dense core creating a large B-FiSS force that would seemingly produce a cuspy Dark Matter signature.

Early active star-forming galaxies have denser concentrations of gaseous and dust like baryonic materials in its outer regions and perhaps have cores that are not as dense. But even if they have dense cores, the matter in the outer regions would provide good screening for the inner core, which would act near Newtonian, hence no cuspy cores.

6.12 Galaxies with 99% Dark Matter - Dragonfly 44

Evidence against the FiSS hypothesis is the observation of Dragonfly 44 which is said to have 99% Dark Matter. Again it's diffuse and as large as the Milky Way and star poor, so FiSS would predict little Dark Matter effects, same as the last two galaxies we looked at, i.e. NGC 1052-DF2 and Antlia 2. This would invalidate FiSS as it stands.

The only possible explanation that we can think of - is that this galaxy is full of unseen dark baryonic matter that, not only provides the extra gravity required, but also the shielding required to produce FiSS forces. Perhaps the galaxy contains a high concentration of dust, and since it is star poor and distant this dust might not be visible or the dust is blocking starlight making it appear star poor. We can also point out dark baryonic matter counts twice, i.e., by producing a normal gravitational field and by the effects produced by FiSS. Still, a galaxy with 99% Dark Matter would be impossible to reconcile with FiSS as it stands, even if the galaxy sat in the middle of a void exposed to a full FiSS flux.

6.13 Dark Matter Disk

Presently, there is weak evidence[35][17] of a 35-26 Myr periodicity in the z-axis movement of the sun through the disk's width, bobbing up and down. However, there is not enough density in the disk to explain the large periodicity. This is explained via a hypothetical Dark Matter Disk, however, S-FiSS and B-FiSS forces from a FiSS flux coming in a semi-hemisphere arc on both sides of the flat sides of the disk could explain this.

6.14 Warm-hot Intergalactic Medium

It's presently poorly understood why these gaseous filaments[36] and dark voids are formed, with Dark Matter needing to be called in to explain them. FiSS, through the effect shown in Fig 8 could explain the stability of these long filaments, namely the very long-range S-FiSS, also see discussion next.

6.15 Rivers of Gravity

Interestingly, a filament was discovered between the Milky Way and Andromeda.[37] While these filaments are predicted from early formation processes in the ΛCDM model, an S-FiSS shadow caused by both galaxies toward each other could be picking up gas and holding it much like an invisible tractor beam. Gas particles traveling into this line of shade would experience a gravitational S-FiSS well inside this region. As per Fig 9b, if we imagine three bodies, the central being a gas atom, this atom experiences an S-FiSS force toward both bodies if it moves out of the shadow cast by each body, but no S-FiSS force inside the doubly shaded areas. Hence FiSS predicts that gas should be getting picked up and trapped as it moves into such bi-directional shadows. As gas builds up in these filaments, it attracts more matter through normal gravity and B-FiSS. This would strangely predict that every galaxy would technically have a filament of gas connecting it to every other nearby galaxy.[15] A kind of cosmic web-like vacuum cleaner.

There are also observed wall-like and tube-like structures of scattered galaxies in The Boötes Void and The Great Void – seemingly again suggestive of the linear shade casting and stabilization effects described in Fig 8b. It would be interesting to see if, at either end of this tube, there exist two large hubs of galaxy clusters.

6.17 Early Galaxy and Super Massive Black Hole Growth

It's presently not understood how mature galaxies and supermassive black holes formed in the early universe could have grown so quickly, the extra forces provided by FiSS could explain this.

6.18 Unexplained Background Radio Emissions and Photons

Our universe exhibits unexplained radio background signals and other electromagnetic radiation, while we may discover the source of these emissions at some stage, it's also possible these contain signatures from the predicted FiSS radiation.

Secondly, we don't know why at present, the universe is so bright[38] (although perhaps resolved[39]). From accounting of light-producing galaxies - and all that's in them - there are four times too many photons in the universe than there should be. Termed the "photon underproduction crisis." It's speculated this stems from decaying Dark Matter or stars outside of galaxies, but it's also possible that this is the radiation that FiSS predicts, and it's being scattered all around us.

Interestingly it's worth noting that the mismatch only appears in the nearby cosmos. While when looking at the early universe, everything seems to add up. This could be evidence for the effect described in Fig 10 where nearby objects appear relatively darker due to FiSS shading by our galaxy while far off galaxies appear relatively brighter due to less shading.

[15] Note, this would also have implications for Hubble's constant calculations for near-by galaxies, depending on our galaxy's relative traverse motion with the galaxy in question.

On the other hand, distant nebulas should be producing and scattering this radiation back to us, yet apart from a few scattered reports of Enormous Ly-α nebulae[40] (ELANe) like the MAMMOTH-1[41] with unexplained emissions, there seems to be no large scale reporting of unexplained radiation powering nebulas. This counts as evidence against FiSS.

6.19 The Intermittent Fly-by Anomaly

Presently, the fly-by anomaly seems to appear only sometime while not at other times resulting in extra velocity upon close fly by the earth. While there are several proposed explanations, there could also be some remaining unscreened FiSS flux coming in from the top and bottom of the Milky Ways disk. A B-FiSS force from the earth could help explain the effect if the bulk of the object's flight path was in the direction following this unscreened FiSS flux toward the earth, which would backscatter the FiSS pulling on the craft. It would be interesting to see if the direction of the flight path relative to the galactic plane, and the appearance of the fly-by anomaly correlate.

6.20 Lone Galaxies in Voids

FiSS seems to predict that lone galaxies in voids, exposed to full strength FiSS flux should look different as compared to galaxies in clusters, and this seems to be the case. In a recent study, it’s shown such galaxies have several unusual characteristics; for example, they are bluer than normal galaxies,[42] which could be consistent with the FiSS less red-shift hypothesis, see Fig 10. Galaxies clustered in large groupings would together create more B-FiSS, which would compound showing more red-shift for light leaving any specific galaxy in the group. A lone galaxy in a void wouldn’t show this effect as much and hence would appear bluer. While there might be other reasons for these differences, it does seem to be consistent with FiSS.

6.21 Excess Star Formation

At the moment, researchers have noticed that galaxies form new stars too fast, consuming more matter then is presently available in the disk. It's hypothesized fresh gas comes in from the intergalactic voids; however, they have found little evidence of this, and indeed the very long range S-FiSS force would not pull on gas between two galaxies, because as mentioned in "Rivers of Gravity" previously, the bi-directional shadows cast by each galaxy would nullify any S-FiSS force felt by gas toward any particular galaxy.

It's unlikely FiSS radiation is even partly powering stars; we'd assume it's far too weak a source, however as hypothesized by others,[43] there is a potential for a recycling process where gas, pushed away from the Milky Way finds its way back again. S-FiSS, in this case, would provide the extra forces required to pull in surrounding gas from a very long-range, as long as there is no collinear galaxy along the line of sight to the gas.

6.22 Axis of evil

Presently there are unexplained fluctuations in the CMB, which align with the plane of our solar system, while our solar system is near perpendicular to our galaxies rotation axis of rotation. The hypothesized FiSS effects shown in Fig 10 could possibly help to explain these effects; however, we are not too familiar with the exact orientations of these anomalies in the CMB, so it's hard for us to comment and we leave it to others.

6.23 The Great Attractor, Dark Flow and Andromeda

It's thought the Milky Way Galaxy is traveling - disk edge first, at a speed of 2.1 million km/h, relative to our universe toward Virgo and the Great Attractor - thought to be the gravitational center of the Laniakea Supercluster, comprised near 100,000 galaxies. Here two observations are unexplained - firstly, local galaxies seem to be moving toward this part of the sky, but Gayoung *et.al.* has proposed that the Laniakea Supercluster is not gravitationally bound.[44] Secondly, galaxies seemingly across the universe are being pulled toward this area; this is termed "Dark Flow" as we understand it.

The first anomaly could be explained by remnants of the very long rage S-FiSS force, whereby local galaxies are being drawn to this gravity center with unusual strength via this very long-range force.

However, we’d assume due to the immense distances; even the S-FiSS force can’t explain the second point. Concepts described in Fig 10 might be the answer, it could be that we haven’t accounted for the hypothesized FiSS effects where our own galaxy’s peculiar motion moving toward this part of the sky is making us view other galaxies in certain parts of the sky as moving toward this point, i.e., “Dark Flow” could be just an artifact of an unaccounted-for FiSS effect; making it seems like these distant galaxies are being pulled toward one direction. However, we’re less sure this.

Lastly, Andromeda may not be moving toward our Milky Way so quickly. While its movement toward our galaxy is explained by their gravitationally bound state and statistically, since we do observe a spread of peculiar motions of galaxies, it could also be that our closest and largest disk galaxy is affected by the shielding mentioned in Fig 10b. Hence, Andromeda might be smaller and closer than it appears (due to shielded FiSS radiation) but not moving toward us as fast as it appears (due to a smaller FiSS redshift).

6.24 Living in a Void

Recently it’s been suggested our Milky Way exists in a local region surrounded by an under-dense spherically symmetric void of galaxies,[45] seeming by chance, violating the Copernican Principle. As mentioned in Fig 10b, FiSS seems to imply, galaxies that are closer to us would appear relatively duller and hence further away, due to our Milky Way’s FiSS shadow preventing the production of FiSS light that would otherwise be produced and scattered back to an observer, bar the existence of our galaxy. This effect could explain the appearance of a spherically under-dense region surrounding us.

6.25 Dark Matter in the Early Universe

It’s hypothesized from the CMB and is thus well accepted generally that Dark Matter (or such effects) must have existed very early on in the universe. In contrast, in FiSS model, Dark Matter effects should arise later. There is presently some strong evidence showing a lack of Dark Matter in the early universe. For example, recent work[46] has indicated that the rotation curves of high-redshift galaxies decrease with radius, indicating these early galaxies were indeed dominated by baryonic matter. Now it may be, as suggested, that Dark Matter required time to condense. However, the observation that Dark Matter’s gravitational effects were not felt so early is yet again entirely consistent with the FiSS framework, namely by its nature FiSS requires time and void space to form.

6.26 “Oh My God” Particles

Cosmic ray particles are primarily created from supernova explosions in our galaxy, but the most energetic of the ultra-high-energy cosmic rays (UHECRs), like the “Oh My God” variety are thought to come from gamma-ray bursts and quasars. The issue is; these high-energy atomic nuclei have so much energy that they break the Greisen–Zatsepin–Kuzmin limit (GZK limit), implying they couldn’t have traveled from extragalactic space and must have come from a source more local to our galaxy, while no such source seems to exist.

The very long range S-FiSS force may be accelerating these nuclei in their final approach to our Milky Way. If so we have a unique FiSS prediction, that cosmic rays traveling faster than the GZK limit, should be coming in from voids, because the S-FiSS collinear bi-shadow with observable galaxies that have no relative traverse motion to our galaxy (see Fig 9b) shouldn’t accelerate UHECRs. Interestingly, Kim *et. al.*,[47] found UHECRs that make it to Earth, are potentially produced in galaxies, travel along gas filaments between galaxies, are then scattered out of these filaments and are now free to be accelerated to the Milky Way by S-FiSS, a picture seemingly consistent with FiSS.

6.28 Disjointed Gravitation and LIGO Bursts

There have been reports of strange bursts of gravitation by LIGO.[48] As Fig 9b implies, there should be an S-FiSS gravitational potential well between two large objects. In the extremely unlikely event that Earth was to pass through such dual shadows, for example, in perfect collinear alignment between our sun and another large star, there could be a disjointed pulse of gravitation observed upon its passing; however, we can’t quite see how even a bidirectionally missing but still continuous FiSS flux environment.

6.29 Ring Galaxies

Ring galaxies like Hoag’s object, have an older inner core and younger outer ring in a strange stable orbit around the central core, with an inner ring largely devoid of material. It’s unclear how these galaxies form. FiSS does, however, predict a weak extra repulsive F-FiSS force. A clue to the galaxy's formation lies in the fact that Hoag's object sits alone with no galaxies around it. So from a FiSS perspective, perhaps after a galaxy merger, an elliptical galaxy was ejected into a void-like region, then long-range F-FiSS forces slowly pulled gaseous material evenly all around forming the ring, with B-FiSS stabilizing a ring. But this doesn't explain why it doesn't form a spiral. It could be that without violent mergers, and if the rotational velocity of the ring is just right, the weak F-FiSS repulsive force (see Fig 9b), produced as FiSS flux goes through the side of the ring circling the central core, is keeping the central core stars in the center and the ring in a stable but fragile orbit. Messier 26 (NGC 6694), an open cluster also has an inexplicable shell unusually devoid of stars, and could also be exhibiting F-FiSS effects.

6.30 Thin Plane of Co-rotating Satellite Galaxies

Yet more evidence for the model comes from another confirmation[49] of that "galaxies are each surrounded by a thin plane of satellite dwarf galaxies that may be corotating," this time for Centaurus A, which shows that the Milky Way and Andromeda are not just "rare statistical outliers." This is not consistent with the ΛCDM, but is yet again entirely compatible with FiSS. From Fig 9b, if Body A comprises a spiral galaxy, with a dense core, any single satellite galaxy Body B, which lags out of collinear alignment with a corresponding pair Body B, gets exposed to a more significant S-FiSS force which will bring the body back into the collinear alignment.

6.31 Summary: FiSS as a Dark Matter Explanation and Testing the Hypothesis

It's rare to find a model that seemingly fits such a broad range of observations. Indeed it's the further unifying aspect of the FiSS model that is so convincing to the author because, as we shall see below, it's also entirely consistent as an explanation for Dark Energy.

The FiSS hypothesis provides a number of falsifiable forces and predictions, however the best differentiating prediction is the following. Dark Matter halos are spheroidal in nature with a gravitational force that falls off with the inverse square law. In the Dark Matter theory, there should be no relationship between the collision velocity and the approach orientation of the disks, i.e., disk edge first or flat sides first. However, FiSS predicts there should be a difference. Bodies in galaxies approaching each other flat side first would see a larger projected aperture area from all the bodies in the other galaxy, while edge approach first, they would not. Hence FiSS predicts disk galaxy approach collision speeds should be correlated to the projected aperture each galaxy sees.

Furthermore, a particle well outside of our galaxy, above the center of the disk (but well within the Dark Matter halo), is predicted by FiSS to have an unusually strong attraction toward the galaxy's center. Here all three forces conspire to pull the particle in; normal gravity, B-FiSS, and S-FiSS, while only the (assumingly weaker) FiSS radiation[16] and F-FiSS acts against this direction. A large Dark Matter halo would not add so much force, at this point above the disk (i.e., due to Newton's shell theorem), over and above normal gravity, because it's very near the center of the Dark Matter halo.

Lastly, if lone Black Holes and Neutron stars in voids could be observed, they should attract a large Dark Matter subhalo since they are some of the heaviest objects in the cosmos after all. While FiSS would state the opposite, these objects, due to their tiny apparent cross-sectional area, should produce very little FiSS effects at all.

7. FiSS and Dark Energy Implications

From our understanding, Dark Energy plays a dual role in cosmology today; firstly, it's the required large Vacuum Energy density term needed to keep the universe flat, and secondly, it provides an anti-gravity effect to produce an accelerated expansion.

If we look at the first point, from the famous Friedmann equations[50] derived from GR, which govern the rate of change in the size of the universe,

$$\left(\frac{\dot{a}}{a}\right)^2 - \frac{8\pi G}{3}\rho - \frac{\Lambda c^2}{3} = -\frac{kc^2}{a^2} \qquad \text{Eq 9}$$

The larger the universe gets, the weaker the gravitational term $-\frac{8\pi G}{3}\rho$ becomes. Now since $\frac{kc^2}{a^2}$ is thought to be near zero due to the measured curvature of the universe, we need Λ to explain the observed rate of change in the size of the universe $(\dot{a}/a)^2$ if we are to believe the Hubble constant.[17] From the FiSS perspective, the gravitational term now becomes much smaller, since we've not only removed or lessened the need for Dark Matter but also stunted gravitational effects of baryonic matter over very long

[16] Technically FiSS radiation from the disk would possibly outweigh the FiSS radiation coming off the body, pushing the body into the disk.
[17] The strength of the effects detailed in Fig 10 will need to be considered.

distances.[18] Hence we need a larger Vacuum Energy; however, depending on how much long-range gravity is stunted - and if Vacuum Energy gravitational effects are stunted in the same way - it could be we need a lot more Vacuum Energy. This could bring the general relativity predicted Vacuum Energy somewhat closer to the much larger value predicted by quantum field theory, helping to resolve the "vacuum catastrophe" problem partly.

Regarding the second role for Dark Energy, from the second Friedmann equation:

$$\frac{\ddot{a}}{a} = -\frac{4\pi G}{3}\rho - \frac{4\pi G p}{c^2} + \frac{\Lambda c^2}{3} \qquad \text{Eq 10}$$

Again if we are to believe the acceleration of expansion in our universe[17] and $\ddot{a}/a$ is a positive value, then as viewed from the FiSS hypotheses, firstly, there is no or less Dark Matter, and secondly the FiSS long-range gravity disruption effect will also further lower the $-\frac{4\pi G}{3}\rho$ term, but even if it were zero, we still have a negative $-\frac{4\pi G p}{c^2}$ term. So we still need a positive (but somewhat smaller) anti-gravity term $\frac{\Lambda c^2}{3}$. Here FiSS radiation, and possibly B-FiSS, and F-FiSS produce the remaining anti-gravity effects we need to balance the equation.

Lastly, the accepted belief that the influence of Dark Energy only arose in an older universe, as well as Dark Energy's seemingly self-inflating characteristics, are also naturally explained in the model, i.e., these FiSS waves would have required time and space to form, developing and growing in strength into ever-larger Dirac function like gravitational energy packets, as our Universe becomes larger and more spacious; filled with voids and less baryonic matter cross-sectional area to provided smoothing effects.

8. Conclusion

We propose the formation and existence of Fine Structured Spacetime (FiSS) in the curvature contribution from far distant parts of the universe, as part - if not full explanations for the anti-gravity effects of Dark Energy and the extra gravitational effect of Dark Matter. These sharp ripples in spacetime are hypothesized to disrupt and reduce the effects of gravity from those distances. It's proposed these

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[18] By an unknown amount, but possibly down to 1/5th the gravitational strength, i.e., the approx. dark matter to byronic matter ratio

ripples passing through a baryonic body, are scrambled and hence re-smoothed, removing any much ripples. The shielding effect then goes on to cast a smoothed spacetime curvature shadow on a second baryonic body, which normally acts on the body. The re-smoothing process is hypothesized to emit radiation directly back toward the source of the waves as well an extra gravitational potential toward the emitting objects.

For a test particle near the edge of a galaxy, it's shown how this could allow a particle to have a constant rotational velocity that is not dependent on the orbital radius, possibly explaining the linear Tully-Fisher relationship, $\log(V) \propto \log(M)$. The hypothesis hence gives a possible physical basis behind Milgrom's empirical law as well as a physical explanation of MONDs transition function, through the concept of FiSS screening, but further than MOND, two more short-range forces are predicted. One of these, namely, backscattered fine structured spacetime (B-FiSS), could explain MONDs inability to describe dwarf galaxies.

It's described how a FiSS derived force could extend to very large distances up to $\sim 10^{+2}$ Mpc, far beyond the inverse square law. The FiSS forces are hypothesized to stabilize spiral arms, ultra-thin disks, potentially galactic bars, and extragalactic line filaments. The hypothesis also seems to help explain, "Jellyfish Galaxies," wide binary rotational velocities, "The Core-Cust Problem," "Dark Matter Disks," and potentially "Dark Flow."

The main falsifiable FiSS prediction to distinguish it from Dark Matter is that disk galaxy collision velocities should have an unusual and significant correlation to the cross-sectional area each galaxy sees of the other. If there is no such correlation – the FiSS hypothesis is falsified.

As can be seen, FiSS seems a remarkably good fit as a unifying model to outstanding unsolved issues in cosmology and astrophysics today across many areas of interest, and provides an abundance of falsifiable predictions; as such, it should be considered as an alternative to ΛCDM.

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