Dark Matter Annihilates & is Neutrinos entirely, and Galaxies emerge from Population III Stars

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Abstract: Details of the dynamic in how different types of galaxies and their interplay emerges from population III stars, alongside evidence speaking for their past existence. But foremostly, a long list of mainly astronomical evidences of which I have identified that they support the hypothesis that dark matter annihilates has been created upon thorough search for predicted instances in which such annihilation signs should and indeed do show up, on the scale of large planets, stars, and galaxies. Several other unexplained or mis-understood but thought to already have been explained phenomena are covered as well and dark matter annihilation should contribute partially or entirely, depending on the case, to their qualitative explanation. The paper however does not cover reasons for why cosmic web pressure between mainly black holes of galaxies represents the concrete mechanism that describes at least a majorly contributing part of the dark energy phenomenon that eventually leads to a big crunch.

In the following, "neutrinos" generally refers to all 6 known to exist kinds of neutrinos (namely of matter or antimatter type and with 3 different flavors), rather than just non-antimatter neutrinos.

According to multiple studies, specifically the presence of so-called ultra-lightweight dark matter in large abundances in the vicinity of black holes appears to resolve the so-called final parsec problem. The known to exist kinds of neutrinos are ultra-lightweight particles.

Simultaneously, if neutrinos were to actually exist in large enough abundances, all the stars' relativistic neutrinos suffice without the need of additional abundant enough other kinds of dark matter to make up the cosmic dark matter web's filaments, which galaxies close to them were to be able to bend more by their gravitation if the particle flow through the filaments were to be slower e.g. if more massive dark matter particles were to not be as likely or abundantly accelerated to or already by default move with relativistic speeds.

Furthermore, there is plenty of evidence speaking for the ability of cold dark matter (CDM) to annihilate with stars' neutrinos, which - according to the standard theory of particle physics - only the anti-particles of the same neutrino-flavor can do (which then either a different dark matter particle type were to have to be able to turn or decay into, which then also would imply a far larger than expected abundance of neutrinos, or otherwise maybe the known types of neutrinos would then have to be able to turn into different dark matter particles, which then probably should've shown up statistically in the plenty dark matter search experiments dealing with or approaching the "neutrino fog"), which specifies, narrows down the type of ultra-lightweight dark matter to these neutrinos (among the current list of CDM particle candidates).

Here is an incomplete list of 30 pieces of evidence that speak for dark matter's ability to either decay (and then especially preferably so nearby stars) upon particle or field interaction or possibly as unstable matter on its own, or to undergo matter-antimatter annihilation:

(i) The so-called core cusp problem: CDM models tend to result in radial galactic CDM distributions that possess a spike, a sharp upward trend in the abundance of CDM near the galactic center, which appears to be in disagreement with best fits of models with which actual astronomical observations of galaxies are approximated, namely where the CDM density near the center is lower.

(ii) The so-called "immortal stars" (as per a recent study) near the Milky Way's center: In this region, the galactic CDM density is assumed to be the highest, and so since stars are intense sources of (relativistic) neutrinos and anti-neutrinos, annihilation of these (anti-)neutrinos and CDM (if it is (anti-)neutrinos) inside them can happen frequently enough to contribute to stars' internal light-pressure, substituting their fusion processes partially, and slowing down with respect to what these stars' normal development would be like.

(iii) The so-called Cepheid mass discrepancy (since many of them are near the galactic center, a high CDM density region): Theoretical mass estimates using stellar evolution and stellar pulsation calculations have been found to differ by approximately 10-20%. The hypothesized interference caused by CDM due to its annihilation within stars is a likely explanation candidate for this phenomenon, since it slows down stellar evolution relative to its normal pace.

(iv) The GS NDG 9422 galaxy's spectrum mystery: It is one of the furthest away and hence at youngest age observed galaxies, at a time during which as mutually annihilating hypothesized (anti-)neutrinos (including CDM neutrinos) would still have contained a much larger abundance of CDM neutrinos that over billions of years would follow more or less an exponential decay curve in their abundance due to less and less likely becoming chances of annihilation the more of finitely many and only in the beginning provided CDM neutrinos were to remain, and this galaxy's spectrum contains a normally absent, tall, sharp intensity spike in the ultra-violet wavelength range, immediately followed by a normally also absent smaller hill-shape that extends towards longer wavelengths. The plausible cause is the annihilation of CDM outside of stars (though possibly with their relativistic neutrinos) for the sharp intensity spike in the UV range, as well as annihilation of CDM within stars leading to a then random-walk-based smeared out hill in the spectrum (as light distributes its energy across more and more photons by repeated absorption and emission processes on its way to exit a star, increasing the wavelength of each photon).

(v) The higher relative CDM abundance in spiral galaxies compared to elliptical galaxies: Since elliptical galaxies fill out more of the 3-dimensional space near their galactic center in more close-meshed manner than spiral galaxies with just their central bulge followed by stars further out almost only being contained within a 2-dimensional plane, elliptical galaxies' stars should - due to their different arrangement - be better equipped to annihilate CDM over billions of years, leaving higher CDM abundances in spiral galaxies than in elliptical ones.

(vi) The fact that closer, at older age seen galaxies tend to have lower (to their baryonic matter abundance) relative CDM abundance than further away located galaxies: Again, qualitatively speaking, this trend would fit to the assumption of CDM being annihilated over time.

(vii) The so-called solar (electron) neutrino problem (in which only about a third of the expected rate of specifically electron neutrinos is detected on earth, which lead to the neutrino flavor-oscillation hypothesis): This phenomenon would be better explainable if some of these neutrinos annihilate with neutrino-based galactic CDM along the way.

(viii) The so-called coronal heating problem (since the sun's surface temperature is higher than expected, for yet not quite fully understood reasons): CDM's annihilation in the vicinity of the sun (as it's an intense neutrino source) would also send highly energetic photons from various distances and directions onto its surface, which would then contribute to an explanation to this heat-related problem.

(ix) The high luminosity and from it inferred and seemingly too high mass of multiple far away galaxies already at young age of the universe: If in ancient times created CDM before galaxies existed were to annihilate away in exponential decay manner, then this would lead to a higher than the only from other light-sources expected to come luminosity by contributing to it, which otherwise would also mistakenly be translated into the too high seeming masses of these galaxies.

(x) The glowing vicinity of the supermassive black hole of our galaxy: Annihilation of CDM in the galactic center, especially nearby the in this region more densely packed stars as neutrino sources could explain this glow.

(xi) The so-called ultra-blue stars that have been found in some galaxies' centers: Similar to point (iv), by CDM annihilation inside stars created UV-light can help better explain the existence of these stars, especially since they have been found in the region they would have to be in (namely galaxies' centers) for CDM annihilation to become significant enough, rather than if they were found in regions with low expected abundance of CDM in a galaxy, in which case for stars closer to the center, many of them should be ultra-blue as well, and even more so.

(xii) So-called UV-bumps in certain stars' spectra (including the sun), making them look like the super-position (by addition of intensities) of spectra resulting from different causes or processes (depending on the local CDM density within and nearby a given star): Again, annihilation of CDM leading to high energy photons is an explanation candidate for this phenomenon and may also lead to some young stars (like those formed at starburst events) appear to be more blue than they normally should be when they are low in mass.

(xiii) The glowing filament segments that exist throughout and around our galaxy: If colliding stellar black holes have CDM orbit them in large abundances and leak streams of CDM as they are accelerated around each other, carrying momentum away and helping resolve the final parsec problem, then this plausible source of these glowing galactic filaments would imply that their glow results from annihilation of these neutrinos with each other and with the galactic CDM.

(xiv) The so-called Maia stars' mysterious pulsation (seemingly without metallicity-based explanation for their pulsation): Varying CDM densities in the regions that these stars move through would be an alternative possible cause of such pulsations, since the internal light-pressure (based on CDM annihilation) would depend on this density.

(xv) The red & yellow & blue straggler stars: These are stars that (relative to representative stars for their type) appear to be too red or too blue, which could be explained by unusual low or high CDM densities (depending on the region a star is in, relative to its galaxy) compared to the average CDM density, since the extent of its annihilation would then contribute to the blue-ness of their appearance.

(xvi) The low-density objects that are the so-called G-objects near the center of the Milky Way galaxy: These are objects that - based on their spectrum - even look like gas but behave like stars and (fittingly) expand when they approach the galactic center, and as such, they may be extreme cases of stars that caged especially large amounts of CDM around themselves, so that its annihilation increases their (coronal) temperature and makes them expand, especially the higher the CDM density is, i.e. when they are close to the galactic center.

(xvii) The mysterious glow inside the solar system, in the sun's vicinity: Once again, if CDM annihilation happens in space, especially nearby the sun for all the over billions of years caught galactic CDM of which parts could with swing-by interactions especially via the more massive gas planets be moved to closer orbits around the sun, then that may explain this phenomenon.

(xviii) The re-ionization of the early universe: If Galaxies started out with highest amounts of CDM initially that back then rapidly annihilated away but later would do so at slower and slower pace, then this annihilation contributing to galaxies' luminosity can help explain the cause of the re-ionization of the gas throughout the universe.

(xix) The existence of blue straggler stars in globular star clusters: These clusters are expected to have been formed in ancient times and to not have (as many) blue straggler stars (since blue stars are expected to be the most massive O and B type stars with highest temperatures that don't last long), and yet they exist, but this may be explainable by globular star clusters caging galactic CDM with in the gravitational wells of such clusters when CDM is slowing down on its way away from the galactic center in its motion of swinging through and around it, to increase the CDM density specifically in such clusters, allowing for more blue stars.

(xx) Galactic glowing filament segments very close to each other appearing to be winding around each other or gravitationally attracting each other: If the cause of these filaments isn't due to other reasons like possibly a galactic magnetic field, then if they appear to attract each other, which in some cases they do, this would speak for invisible CDM particle flows (in very large abundances for gravitational attraction to be noticeable) causing these (then due to annihilation) glowing filament segments.

(xxi) Galactic glowing filament segments appearing to be tidally stretched differently much, depending on their location and orientation with respect to the Milky Way galaxy: Again, if CDM particle flows describe these filaments, then the fact that they are more stretched near the galactic center when their orientation is close to orthogonal to the galactic plane (so that the whole plane is one 1 side of the filament, pulling on its parts differently strong, depending on the distance) compared to when they are oriented closer to a direction parallel to the plane can be better explained.

(xxii) Prof. Dr. Richard Massey's dark matter distribution map from 2007: It supports the hypothesis that black holes in general (including super-massive black holes) at collision eject or leak dark matter escaping their gravitational wells (depending on how the masses of colliding black holes compare, which affects how much either of them is accelerated and hence which of them leak how much CDM, if any) in the first place, given the (double-)cone shape(s) that every single dark matter bubble in the reconstructed distribution map possesses.

(xxiii) The glow of young brown dwarfs: Based on current explanation attempts, they're supposed to glow due to left-over heat from the formation and due to the shrinking process, or to even glow due to some instances of fusion, but alternatively, by attracting galactic CDM and annihilation of it (with itself, so without relativistic neutrinos from stars in this case) in their vicinity, similar to the coronal heating problem's situation, see (viii), leading to radiation onto their surfaces, this could heat them up and contribute to the full explanation.

Evidences besides annihilation that speak specifically for neutrinos as CDM, including evidences that speak for super-massive pop. III stars' existence, since they (due to their exceptionally deep gravitational wells that the initially relativistic, escaping neutrinos produced in fusion down there would be slowed down by) would be needed as source for slow neutrinos:

(xxiv) The elongated, baguette- or banana-like shape of in youngest stage of development recently at furthest distances discovered galaxies: These shapes indicate that the origin of galaxies does come from population III stars, namely as the result of asymmetric collapse processes of these super-massive stars, in which the massive black holes in their center would be in an unstable inward pressure equilibrium, which once the pressure from all sides gets out of balance may more and more push the central black hole out of the star in some direction, while the star undergoes its supernova, after which its former plasma would be gravitationally attracted towards the location to which the black hole was kicked out, to then swing back and forth around its location (or rather their shared overall gravitational center) for an extended time.

(xxv) The existence of massive so-called hyper-velocity (O and B type) stars: The fact that their stellar black hole remnants can get a kick when these stars undergo a supernova event support the possibility of a similar process plausible being possible for the hypothesized ancient population III stars.

(xxvi) The existence of satellite galaxies in the first place, especially around spiral galaxies, and their arrangement, namely being located in or close to a plane, both for our galaxy and in the case of the Andromeda spiral galaxy with its satellite galaxies: This also speaks for population III stars' existence and their asymmetric collapse dynamic, since especially if the in them contained massive black hole gets kicked out at small angle to their plane of rotation (rather than at close angle to their axis of rotation), then for these (due to their rotation and the centrifugal force) rotational ellipsoid shaped stars, this should rather lead to the formation of a future spiral galaxy, and roughly 1 hemi-sphere of plasma of the star will be moving in the opposite (or up to orthogonal) direction to the direction to which the interior black hole is kicked out of when the supernova event happens, while the other hemi-sphere will be (to different degrees) moving with it, and so the former hemi-sphere that moves in the opposite direction will especially near the equatorial plane be able to separate itself the fastest and furthest from the massive black hole, as it is ejected into with gas filled space in the early universe, which (by rapidly induced increasing mass-density) seeds the formation of further population III stars from eventually collapsing gas clouds more likely there, namely close to this plane, than elsewhere, and compared to if the black hole in the core were to have been ejected at small angle to the axis of rotation of the pop. III star (which should rather turn the from it resulting galaxy into an elliptical one), more mass should be able to be separated from the massive black hole (and around it forming galaxy), consistently to observations leading to less massive galaxies, namely of disc or spiral shape, than what the mass of elliptical galaxies tends to be like.

(xxvii) The ratio of elliptical galaxies to spiral galaxies, or that statistically there is more spiral galaxies than elliptical galaxies: Assuming that population III stars indeed are what galaxies originate from and that asymmetric ejection of massive black holes in their cores lead rather to spiral galaxies if the direction of ejection is at small angle to their plane of rotation, and that otherwise, at small angle of ejection to their axis of rotation, the resulting galaxy is rather an elliptical one, the larger abundance of spiral galaxies can be explained due to the probability (assuming near uniform probability distribution for the direction of outward ejection of the black hole at the core) of the black hole at the core being ejected at small angle to the plane of rotation being higher than if it were ejected at small angle to the axis of rotation instead.

(xxviii) The higher metallicity of our galaxy compared to at least 1 of its satellite galaxies, based on the metallicity of a representative star of it: In a study, the iron abundance of a star of 1 of Milky Way's satellite galaxies was compared to the typical abundance of iron in stars of our galaxy and it was found to be lower, speaking for a later formation of a population III star creating this satellite galaxy upon supernova explosion, which is consistent with that population III star's formation having happened at later time than that of the population III star that formed our galaxy, which is consistent with its formation having been caused by the supernova explosion of our galaxy's former population III star, if they existed. And due to the layering of differently heavy chemical elements in stars in general but in particular in our galaxy's preceding pop. III star, less metallicity would have been ejected by its supernova to further away regions to end up in satellite galaxies compared to the Milky Way galaxy.

(xxix) The larger mass of our galaxy compared to its satellite galaxies, and the same for the Andromeda galaxy: This would be consistent with the formation of those galaxies having started later in the early universe, when the cosmic gas density from which to form those stars already was lower, and hence the possibility that our galaxy's former population III star triggered their formation with its own supernova.

(xxx) All heavier kinds of quark and neutrino flavors are unstable, and so if this pattern applies in general, then heavier dark matter may be unstable as well and decay or turn into stable but less massive dark matter, of which the ultra-lightweight neutrinos would be a suitable candidate (even though their hypothesized flavor oscillations indicate that even they may not be quite stable in flavor).

Additionally, in the pathway of trying to explain all of dark matter to be the known kinds of neutrinos, there appear to be 2 or possibly 3 major hurdles that need to be resolved:

I. Current estimates on their abundance indicate an insufficient abundance to make up all of dark matter.

II. Vast amounts of dark matter is bound to individual galaxies or groups, clusters of galaxies, but all neutrinos are created with relativistic speeds with which they cannot stay bound to galaxies unless for enough of them, a mechanism existed by which they can be slowed down sufficiently much.

III. The so-called Tremaine-Gunn bound based on Pauli's exclusion principle in (the not yet fully understood) quantum mechanics puts an upper limit on how densely neutrinos as fermionic matter can be packed, which might lead to problems for if too high CDM densities were to be required to be present in the vicinity of various kinds of black holes and to explain phenomena causally related to the quantitative abundance of CDM near black holes, compared to how densely neutrinos as CDM particle candidates could be packed. Seemingly only the Tremaine-Gunn bound, an estimate - relying on & based on the for fermions such as neutrinos applying Pauli exclusion principle as well as the assumed effective radius of the in flavor oscillating neutrinos - which is about the hypothetical maximal possible neutrino density in a given region of space - were to remain speaking against neutrinos as dark matter, but there's no observational confirmation of such limit and it may be far too low for various thinkable plausible reasons such as there possibly existing more state determining parameters for neutrinos, and with each further parameter, the number of (based on associated exclusion rules) stackable neutrinos may grow exponentially and allow for sufficiently heavy neutrino clouds.

In order to address the first hurdle (I.) even if physicists (for their abundance estimates on the total amount of neutrinos) would already have accounted for the increased difficulty of detection of especially ancient neutrinos for if they assume space inflation's existence in their models (which not all cosmological models do), and that space inflation were to slow ancient neutrinos down and make them harder to detect, then independent of if this is the case or if instead gravitational red-shift of light (and gravitational slowdown of such neutrinos) were the actual underlying cause (if matter were to not exist infinitely far in every direction, and if the cosmological scale overall gravitational well were to become less deep as galaxies move away from each other) were inflation were to not exist or were to be weaker, then they'd still be off in their abundance (under-)estimates of neutrinos because in the former models they'd assume these neutrinos existed more or less uniformly distributed throughout space, to then be slowed down, but if their origin is in the depths of population III stars, then there'd be an additional slowdown to be accounted for, based on this specific origin. Independent of it being space inflation or a cosmological gravitational well being reduced in its depth to slow down ancient neutrinos, given that physicists still have competing hypotheses about how super-massive black holes were formed, namely step-wise by the merging of less massive stars, or from super-massive individual stars with far deeper gravitational wells each, they may not assume the additional slowdown of neutrinos that would come with such population III stars if they don't use models that involve them, and hence would under-estimate the abundance of neutrinos if they took a model in which the supermassive black holes formed by repeated merger processes of ancient stars. Besides this, according to a study, the Milky Way is a "neutrino desert", which may lead to neutrino abundance estimates for the universe in general to be too low.

In regard to the second hurdle (II.), if ancient neutrinos were formed deep down in the gravitational wells of super-massive, uniquely gargantuan, roughly solar-system-sized population III stars, then even with initial relativistic speeds, they could be slowed down enough by their extraordinary gravity to from that point onward end up as slow neutrinos, i.e. as cold dark matter.

References for related studies:

On Arxiv: "Final parsec problem of black hole mergers and ultralight dark matter" (though at this point, as far as I know, there should already be further studies supporting this result)

Youtube video with this title: "Strange Discoveries About Dark Matter Including Immortal Stars" (in general, links to studies are in Anton Petrov's videos' description boxes)

Glowing, hot brown dwarf planets:

Youtube video with this title: "3 Brown Dwarfs That Defy Current Physics Models"

For asymmetric star-collapse and so-called hyper-velocity (O or B type) stars, one can find studies pointing out:

"While matter is thrown out by the explosion more strongly to one side, the neutron star receives a kick in the opposite direction."

Youtube video with this title: "Exploring The Origin of Runaway Stars Escaping The Galaxy, What Forms Them?"

UV-bump in the spectrum of the sun:

Youtube video with this title: "Decoding the cosmos - with Hiranya Peiris"

G-objects:

Youtube video with this title: "G-objects: Strange New Discovery From The Galactic Center"

Youtube video with this title: "Strange Star Like Objects Around Central Black Hole Finally Explained"

Information on so-called ultra-blue stars can be easily found online as well.

Satellite-galaxies tend to be located within a plane around Andromeda or our galaxy, respectively:

Youtube video with this title: "Major Mystery of Galactic Orbits Around Milky Way Potentially Solved"

Glowing (segments of) filaments around our galaxy:

Youtube video with this title: "Turns Out Magnetic Filaments In The Milky Way Are Different Compared to Other Galaxies"

Youtube video with this title: "1000 Of Unexplained Radio Filaments Found In Milky Way's Center"

Youtube video with this title: "Strange Filament Structures Found in Milky Way's Center"

Youtube video with this title: "Mysterious Filament Structures Stretching Toward Milky Way Black Hole"

As visualization for intuitively understanding population III stars (except that the spherical supernova shown shouldn't lead to a spiral galaxy and that even just near or entirely symmetrical collapse – leaving the central black hole stationary - should be highly unlikely):

Youtube video with this title: "Black Hole Star – The Star That Shouldn't Exist"

The glow in the vicinity of the super-massive black hole of our galaxy:

Youtube video with this title: "Mysterious Glow In The Middle of Milky Way, But What is It?"

The mysterious glow of space near the sun:

Youtube video with this title: "Hubble Uncovers Mystery Glow Inside the Solar System, But What's Causing It?"

Blue stragglers in globular star clusters:

On Arxiv: "Blue Stragglers in Globular Clusters: Observations, Statistics and Physics"

Prof. Massey's Dark Matter Map can easily be found online.

Citing an online source on the Cepheid mass discrepancy:

"A longstanding challenge for understanding classical Cepheids is the Cepheid mass discrepancy, where theoretical mass estimates using stellar evolution and stellar pulsation calculations have been found to differ by approximately 10-20%."

Youtube video with this title: About the GS NDG 9422 galaxy: "JWST finds galaxy where the gas outshines the stars?! | Night Sky News October 2024"

A podcast about the baguette- or stick-shaped, furthest away located galaxies:

Youtube video with this title: "#10 - Viraj Pandya - Early Galaxies with JWST, Galaxies "Gone Bananas", Galaxy Formation"

An explanation on Maia stars and their mystery:

Youtube video with this title: "Prof. G. Handler (CAMK PAS): The enigmatic “Maia variables”: an impossible class of pulsating stars?"

"For stars to exhibit pulsations, a mechanism driving the oscillations is required. Several such mechanisms are known and are associated with certain properties of the oscillating star. As a consequence, different groups of pulsating stars occur in specific regions in the HR Diagram: their instability strips. However, there have been reports of pulsating stars outside of the known instability strips. Perhaps the most (in)famous ones have been named the "Maia variables", a group of late B to early A type stars that apparently show pressure mode oscillations, but are located outside any known instability strips. The existence of such variables has been controversial since the 1950s and it has meanwhile been demonstrated that Maia itself does not show detectable pulsations. Nevertheless, in recent years some reports of related objects have appeared in the literature, mostly based on highly accurate space photometry. To investigate the nature of these objects, we have obtained and analyzed high resolution spectra of 31 of these objects as well as examined their TESS photometric data. According to our results, many of these stars are normal pulsators of the Beta Cephei and Delta Scuti types, but some objects remain outside of any known instability strip. We have checked those for contamination in the large TESS pixels, possible binarity and rapid rotation. In this presentation, we discuss how many of those stars can indeed be considered to be pulsators "without a cause" (if any) and why, and whether there is substantial evidence for a class of "Maia variables." ?Wednesday colloquium at CTP PAS – 2024-03-13"

Cosmic red-shift alternatively explained as gravitational redshift with respect to the gravitational potential well of the mass of the entire universe, or evidence (namely supernovae of more distant stars lasting longer, as well as the gravitational time dilation that is associated with deeper locations in gravitational potential wells, according to general relativity theory), which are qualitatively consistent with it:

Space forum article with this title: "Bizarre 3-Year-Long Supernova Defies Our Understanding of How Stars Die"

Youtube video with this title: "Time Ran Slower in the Past, Physicists Find"

In addition, there is another piece of evidence that I hadn't mentioned yet, namely the glow of (also) neutron stars:

Youtube video with this title: "Do Neutron Stars Shine In Dark Matter?"

Statistics on how more distant, younger-stage galaxies tend to have more dark matter (relatively speaking) than those seen at older ages can be researched, as can statistics on the relative abundance of spiral galaxies to elliptical galaxies and which of the two types tends to have more dark matter.