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Astrophysics: Macroobject Shell Model

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Abstract

The model proposes that Nuclei of all macroobjects (Galaxy clusters, Galaxies, Star clusters, Extrasolar systems) are made up of Dark Matter Particles (DMP). These Nuclei are surrounded by Shells composed of both Dark and Baryonic matter. This model is used to explain various astrophysical phenomena: Multiwavelength Pulsars; Binary Millisecond Pulsars; Gamma-Ray Bursts; Fast Radio Bursts; Young Stellar Object Dippers; Starburst Galaxies; Gravitational Waves. New types of Fermi Compact Stars made of DMP are introduced: Neutralino star, WIMP star, and DIRAC star. Gamma-Ray Pulsars are rotating Neutralino and WIMP stars. Merger of binary DIRAC stars can be a source of Gravitational waves.

Keywords

Hypersphere World-Universe Model, Medium of the World, Macroobject Shell Model, Dark Matter Particles, Gamma-Ray Bursts, Fast Radio Bursts, Multiwavelength Pulsars, Binary Millisecond Pulsars, Young Stellar Object Dippers, Starburst Galaxies, Gravitational Waves

1. Introduction

This paper is an elaboration of Hypersphere World-Universe Model published in [1]-[7]. The prospect that Dark Matter Particles (DMP) might be observed in Centers of Macroobjects has drawn many new researchers to the field in the last forty years. Indirect effects in cosmic rays and gamma-ray background from the annihilation of cold Dark Matter (DM) in the form of heavy stable neutral leptons in Galaxies were considered in [8]-[13]. The role of cold DM in the formation of Primordial Luminous Objects is discussed in [14].

A mechanism whereby DM in protostellar halos plays a role in the formation of the first stars is discussed in [15]. Heat from neutralino DM annihilation is shown to overwhelm any cooling mechanism, consequently impeding the star formation process. A "dark star" powered by DM annihilation instead of nuclear fusion may result [15]. Dark stars are in hydrostatic and thermal equilibrium, but with an unusual power source. Weakly Interacting Massive Particles (WIMPs) are among the best candidates for DM [16].

Two-component DM systems consisting of bosonic and fermionic components are proposed for the explanation of emission lines from the bulge of Milky Way galaxy. C. Boehm, P. Fayet, and J. Silk analyze the possibility of two coannihilating neutral and stable DMP: a heavy fermion for example, like the lightest neutralino (>100 GeV) and the other one a possibly light spin-0 particle (~100 MeV) [17].

Conversions and semi-annihilations of DMP in addition to the standard DM annihilations are considered in a three-component DM system [18]. Multicomponent DM models consisting of both bosonic and fermionic components were analyzed in literature (for example, see [19]-[24] and references therein).

Hypersphere World-Universe Model (WUM) proposes five-component DM system consisting of two couples of coannihilating DMP: a heavy fermion—neutralino with mass 1.3 TeV and a light spin-0 boson—DIRAC (dipole of Dirac monopoles) with mass 70 MeV; a heavy fermion—WIMP with mass 9.6 GeV and a light spin-0 boson—ELOP (preons dipole) with mass 340 keV; and a light fermion—sterile neutrino with mass 3.7 keV [2].

The Model discusses the possibility of all macroobject Cores consisting of DMP (galaxy clusters, galaxies, star clusters, extrasolar systems, and planets) and explains the diffuse cosmic gamma-ray background radiation as the sum of contributions of multicomponent DM annihilation. The signatures of DMP annihilation with expected masses of 1.3 TeV, 9.6 GeV, 70 MeV, 340 keV, and 3.7 keV, are found in spectra of the diffuse gamma-ray background and the emission of various macroobjects in the World [2].

In Section 2, we present the numerical values for parameters of Macroobjects' shells made up of different fermions. In Section 3, we discuss Macroobject Shell Model. We give explanations for different astrophysical phenomena: Multiwavelength Pulsars (Section 4); Binary Millisecond Pulsars (Section 5); Young Stellar Object Dippers (Section 6); Long-Term Radio Variability (Section 7); Gamma-Ray Bursts (Section 8); Fast Radio Bursts (Section 9); Starburst galaxies (Section 10); Gravitational Waves (Section 11)—through the frames of Macroobject Shell Model.

2. Macroobjects

According to WUM, Cores of macroobjects of the World (galaxy clusters, galaxies, star clusters, and extrasolar systems) are Fermion Compact Stars (FCS). They have Nuclei made up of strongly interacting WIMPs or neutralinos surrounded by different shells [2]. The theory of FCS made up of DMP is well developed. Scaling solutions are derived for a free and an interacting Fermi gas in [2]. **Table 1** describes the numerical values for maximum mass and minimum

Table 1. Numerical values for masses and radii of FCS made up of different fermions.

Fermion	Fermion mass m_f, MeV/c^2	Macroobject mass M_{max}, kg	Macroobject radius R_{min}, m	Macroobject density ρ_{max}, kg/m^3
Interacting neutralinos	1.315×10^3	1.9×10^{30}	8.6×10^3	7.2×10^{17}
Interacting WIMPs	9.596	1.9×10^{30}	8.6×10^3	7.2×10^{17}
Neutron (star)	939.6	1.9×10^{30}	8.6×10^3	7.2×10^{17}
Electron; proton (white dwarf shell)	0.511; 938.3	1.9×10^{30}	1.6×10^7	1.2×10^8
Dirac Monopole (star cluster shell)	$\gtrsim 35$	1.4×10^{33}	6.2×10^6	1.4×10^{12}
Preon (galaxy shell)	$\gtrsim 0.17$	5.9×10^{37}	2.6×10^{11}	7.8×10^2
Sterile neutrino (galaxy cluster shell)	3.73×10^{-3}	1.2×10^{41}	5.4×10^{14}	1.8×10^{-4}

radius of Macroobjects' Nuclei and Shells made up of different fermions:

Macroobjects' Cores consist of Nuclei (neutralinos and WIMPs) and shells made up of various fermions. The shells envelope one another, like a Russian doll. The lighter a fermion—the greater the radius and the mass of its shell. Innermost shells are the smallest and are made up of heaviest fermions; outer shells are larger and consist of lighter particles.

The calculated parameters of the shells show that [2]:

- White Dwarf Shells (WDS) around the Nuclei made of strongly interacting WIMPs or neutralinos compose Cores of stars in extrasolar systems;
- Shells of dissociated DIRACs to monopoles around the Nuclei made of strongly interacting WIMPs or neutralinos form Cores of star clusters;
- Shells of dissociated ELOPs to preons around the Nuclei made of strongly interacting WIMPs or neutralinos constitute Cores of galaxies;
- Shells of sterile neutrinos around the Nuclei made of strongly interacting WIMPs or neutralinos make up Cores of galaxy clusters.

3. Macroobject Shell Model

In our view, Macroobjects of the World possess the following properties [6]:

- Nuclei are made up of DMP. Surrounding shells contain DM and baryonic matter;
- Nuclei and shells are growing in time proportionally to square root of cosmological time $\propto \tau^{1/2}$ until one of them reaches the critical point of its local stability, at which it detonates. The energy released during detonation is produced by the annihilation of DMP. The detonation process does not destroy the Macroobject; instead, Hyper-flares occur in active regions of the

shells, analogous to Solar flares;

- All other DMP in different shells can start annihilation process as the result of the first detonation;
- Different emission lines in spectra of bursts are connected to the Macroobjects' structure which depends on the composition of the Nuclei and surrounding shells made up of DMP. Consequently, the diversity of Very High Energy Bursts has a clear explanation;
- Afterglow is a result of processes developing in Nuclei and shells after detonation.

4. Multiwavelength Pulsars

D. J. Thompson in the review "Gamma Ray Pulsars: Multiwavelength Observations" presents the light curves from seven highest-confidence gamma-ray pulsars (in 2003) in five energy bands: radio, optical, soft X-ray (<1 keV), hard X-ray/soft gamma ray (~10 keV – 1 MeV), and hard gamma ray (above 100 MeV). Gamma rays are frequently the dominant component of the radiated power. According to D. J. Thompson, for all known Gamma-Ray Pulsars (GRP), multiwavelength observations and theoretical models based on such observations offer the prospect of gaining a broad understanding of these rotating neutron stars [25].

WUM: FCS made up of strongly interacting neutralinos and WIMPs have maximum mass and minimum size which are equal to parameters of neutron stars (see **Table 1**). It follows that GRP might be in fact rotating Neutralino star or WIMP star. The nuclei of such pulsars may also be made up of the mixture of neutralinos (1.3 TeV) and WIMPs (9.6 GeV) surrounded by shells composed of other DMP. The GRP multiwavelength radiation depends on the composition of Nucleus and shells.

S. Ansoldi, *et al.* report the most energetic pulsed emission ever detected from the Crab pulsar reaching up to 1.5 TeV. Such TeV pulsed quants require a parent population of electrons with a Lorentz factor of at least 5×10^{6}. These results strongly suggest Inverse Compton scattering off low energy photons as the emission mechanism [26].

WUM: Very High Energy (VHE) pulsed emission from the Crab pulsar can be explained by active area of rotating Star composed of a mixture of strongly interacting neutralinos (1.3 TeV) and WIMPs (9.6 GeV).

Ge Chen, *et al.* (2015) report hard X-ray observations of the young rotation-powered radio pulsar PSR B1509. The log parabolic model describes the NuSTAR data, as well as previously published gamma-ray data obtained with COMPTEL and AGILE, all together spanning 3 keV through 500 MeV. Astronomers' opinion is that the obtained results support a model in which the pulsar's lack of GeV emission is due to viewing geometry, with the X-rays originating from synchrotron emission from secondary pairs in the magnetosphere [27].

WUM: Multiwavelength emission from pulsar PSR B1509 can be explained by rotating WIMP star with an active area irradiating gamma quants with energy 9.6 GeV which interact with surrounding shells, causing them to glow in X-ray spectrum.

5. Binary Millisecond Pulsars

The properties of the growing class of radio pulsars with low-mass companions are discussed in literature (see [28], [29], [30] and references therein). During a survey of the southern sky for millisecond pulsars, S. Johnston, *et al.* have discovered pulsar PSR J0437-4715 with by far the greatest flux density of any known millisecond pulsar [28].

M. Bailes, *et al.* report the discovery of three binary millisecond pulsars in circular orbits with low-mass companions PSR J0034-0534, PSR J1045-4509, and PSR J2145-0750 that have pulse periods of 1.87, 7.47, and 16.05 ms. PSR J2145-0750 has a spin-down age of approximately greater than 12 Gyr, which raises interesting questions about its progenitor and initial pulse period [29].

IGR~J18245-2452/PSR J1824-2452I is one of the rare transitional accreting millisecond X-ray pulsars, showing direct evidence of switches between states of rotation powered radio pulsations and accretion powered X-ray pulsations, dubbed transitional pulsars. IGR~J18245-2452 is the only transitional pulsar so far to have shown a full accretion episode. V. De Falco, *et al.* have found that the observed spectrum in the energy range 0.4 - 250 keV is the hardest among the accreting millisecond X-ray pulsars [30].

Binary millisecond pulsar PSR J1311-3430 was found via gamma-ray pulsations. The system is explained by a model where mass from a low mass companion is transferred onto the pulsar, increasing the mass of the pulsar and decreasing its period. Pulse-phase-averaged gamma-ray spectral energy distribution for PSR J1311-3430 has cut-off about 10 GeV [31].

WUM: These experimental results can be explained by rotating WIMP star made up of strongly interacting WIMPs (9.6 GeV) with mass (energy) that is growing in time proportionally to the root square of the third power of cosmological time $\propto \tau^{3/2}$ [2]. WIMP star is receiving mass (energy) at the rate $W_r \propto \tau^{1/2}$. In case, when power received W_r is greater than the gamma-ray power irradiated by the active area of the rotating WIMP star, the decreasing of its period will be observed. Then there is no need to introduce a low-mass companion.

6. Young Stellar Object Dippers

The Mysterious Star KIC 8462852 which has large irregular dimmings, is a main-sequence star, with a rotation period ~0.88 day, that exhibits no significant Infrared excess. A stellar mass is $M = 1.43 M_\odot$, luminosity $L = 4.68 L_\odot$, and radius $R = 1.58 R_\odot$. While KIC 8462852's age was initially estimated to be hundreds of millions of years old, a number of astronomers have argued that it could be much younger—just like EPIC 204278916. Young stars with protoplanetary disks should emit light in the infrared, and observations with NASA's Infrared Telescope Facility came up empty. The infrared observations also show no evidence for warm dust, which would exist if a planetary collision debris were at play [32].

The obtained in [32] results show that the 0.88-day signal is present in most of the Kepler time series, with the strongest presence occurring around day 1200. Interestingly however, around day 400 and day 1400, T. S. Boyajian, *et al.* observed major contributions at different frequencies, corresponding to 0.96 days and 0.90 days, respectively.

Several hypotheses have been proposed to explain the star's large irregular changes in brightness as measured by its light curve, but none to date fully explain all aspects of the curve. A prominent hypothesis, based on a lack of observed infrared light, posits a swarm of cold, dusty comet fragments in a highly eccentric orbit. However, the notion that disturbed comets from such a cloud could exist in high enough numbers to obscure 22% of the star's observed luminosity has been doubted (see references in [32]).

EPIC 204278916 has been serendipitously discovered from its K2 light curve which displays irregular dimmings of up to 65% for ≈25 consecutive days out of 78.8 days of observations. For the remaining duration of the observations, the variability is highly periodic and attributed to stellar rotation. The star is a young, low-mass pre-main-sequence star about five million years old. The inferred radius of this star is $R = 0.97R_{\odot}$, while the stellar mass is $M \sim 0.5M_{\odot}$ [33]. S. Scaringi, *et al.* examined the K2 light curve in detail and hypothesize that the irregular dimmings are caused by either a warped inner-disk edge or transiting cometary-like objects in either circular or eccentric orbits. In authors' opinion, the discussed explanations are particularly relevant for other recently discovered young objects with similar absorption dips [34], [35].

M. Ansdell, *et al.* identified ~25 dippers in the young (≲10 Myr), nearby (~120 - 145 Myr) Upper Sco and ρ Oph star-forming regions and proposed alternative mechanisms to explain the dips, namely occulting disk warps, vortices, and forming planetesimals [34]. Most of the proposed mechanisms assume nearly edge-on viewing geometries. However, an analysis of the known dippers by M. Ansdell, *et al.* shows that nearly edge-on viewing geometries are not a defining characteristic of the dippers and that additional models should be explored [35].

M. Sucerquia, *et al.* studied the dynamics of a tilted exoring. They performed numerical simulations and semi-analytical calculations of the evolving ring's properties and their related transit observables and found that tilted ringed structures undergo short-term changes in shape and orientation that are manifested as strong variations of transit depth and contact times [36].

M. A. Sheikh, *et al.* performed a statistical analysis of small dimming events by using methods found useful for avalanches in ferromagnetism and plastic flow. Scaling collapses suggest that this star may be near a nonequilibrium critical point. The large dimming events are interpreted as avalanches marked by modified dynamics. If KIC 8462852 is near a nonequilibrium phase transition, this could also explain the random times at which the large events occur in the light curve. In authors' opinion, "*there is more work to be done in order to verify that KIC* 8462852 *is near a critical point. A detailed theory of stellar processes is necessary to answer what the key tuning parameters are.*" [37]

WUM: These experimental results can be explained the following way:

- KIC 8462852 and EPIC 204278916 have average density about 3 and 2 times smaller than the average density of Sun respectively;
- In frames of WUM, the Nuclei of these stars made of DMP (neutralinos or WIMPs) have densities smaller than nuclear density (see **Table 1**);
- This relatively low density makes density fluctuations inside of the Nucleus possible;
- An annihilation of neutralinos or WIMPs depends on a concentration of DMP squared $\propto n_{\mathrm{DMP}}^2$;
- As the result of the huge density fluctuation, some bulk of the Nucleus can arise in which the annihilation process ceases. It will cause a drop of the star luminosity in this area;
- The Nucleus is rotating (~0.88 days in case of KIC 8462852) and consequently the regular dimming events are observed;
- Change in the position of the huge density fluctuation inside of the Nucleus is responsible for the change of the regular dimming event frequency from ~ 0.88 days (around day 1200) to ~0.96 and ~0.90 days (around day 400 and day 1400) respectively [32].
- Irregular dimming events are the result of random density fluctuations in the bulk of Nucleus.

7. Long-Term Radio Variability

H. K. Vedantham, *et al.* report the discovery of a rare new form of long-term radio variability in the light-curves of active galaxies (AG)—Symmetric Achromatic Variability (SAV)—a pair of opposed and strongly skewed peaks in the radio flux density observed over a broad frequency range. They propose that SAV arises through gravitational milli-lensing when relativistically moving features in AG jets move through gravitational lensing caustics created by macroobject with mass in the range $\left(10^3 - 10^6\right) M_\odot$—a range that embraces intermediate-mass black holes, cores of globular clusters, dense molecular cloud cores, and compact dark matter halos [38].

WUM: Potential lens candidates with these properties are the following compact objects (see **Table 1**):

- Cores of star clusters with shells built up from Dirac monopoles and masses of about $10^3 M_\odot$;
- Cores of galaxies with shells made up of preons and masses of up to $10^7 M_\odot$.

8. Gamma-Ray Bursts

Gamma-Ray Bursts (GRBs) status after 50 years of investigations looks as follows [6]:

- The intense radiation of most observed GRBs is believed to be released when a rapidly rotating, high-mass star collapses to form a neutron star, quark star, or black hole;
- Short GRBs appear to originate from merger of binary neutron stars;
- Seven known soft gamma repeaters are not catastrophic astrophysical events.

WUM: The experimental results for GRBs have the following explanation [6]:

- Nature of GRBs—Nuclei and shells of galaxies made up of DMP;
- Gamma-ray bursts convert energy into radiation through annihilation of DMP;
- Spectrum of GRBs depends on composition of Nuclei and shells;
- Afterglow is a result of processes developing in the Nuclei and shells after detonation.

9. Fast Radio Bursts

The Lorimer Burst (FRB 010724) was discovered in 2007 in archived data taken in 2001. Just after the publication of the e-print with the first discovery, it was proposed that Fast Radio Bursts (FRBs) could be related to hyperflares of magnetars. A more likely explanation is a merger of a pair of neutron stars which form a black hole. Later it was suggested that following dark matter-induced collapse of pulsars, the resulting expulsion of the pulsar magnetospheres could be the source of fast radio bursts (see [6] and references therein).

L. G. Spitler, *et al.* [39] and P. Scholz, *et al.* [40] report on simultaneous X-ray, gamma-ray, and radio observations of the repeating Fast Radio Burst FRB 121102. They have detected six additional radio bursts from this source for a total of 17 bursts from this source. This repeating FRB is inconsistent with all the catastrophic event models put forward previously for FRBs.

V. Gajjar, *et al.* detected 15 bursts at 4 - 8 GHz band from FRB 121102 which is the only one known to repeat: more than 150 high-energy bursts have been observed coming from the dwarf galaxy about 3 billion light years from Earth [41]. These are the highest frequency and widest bandwidth detections of bursts from FRB 121102 obtained to-date [42].

Z. G. Dai, *et al.* propose a different model, in which highly magnetized pulsars travel through asteroid belts of other stars and show that a repeating FRB could originate from such a pulsar encountering lots of asteroids in the belt [43].

WUM: At high temperatures, preon dipoles break up into two preons with mass about $m_{pr} = 1/3 m_e$ and charge $e_{pr} = 1/3 e$ [6]. FRBs are the result of preons' plasma instability triggering shock waves of gigantic electrical currents and generating huge amount of energy in transient radio pulses.

The described picture is consistent with experimental results for FRBs [44]:

- Transient gamma-ray counterpart to FRB 131104 with output energy

$E_\gamma \approx 5\times10^{44}$ J is 10 orders of magnitude smaller than the maximum energy of preons' plasma shell (see **Table 1**);

- Gamma rays in the range 15 - 150 keV are a consequence of preons' annihilation with mass $m_{pr} \cong 170 keV / c^2$.

Repeating FRBs can be explained by galaxy Hyper-flares analogous to Solar flares [6].

10. Starburst Galaxies

Wikipedia has this to say about Starburst Galaxies:

A starburst galaxy is a galaxy undergoing an exceptionally high rate of star formation. Astronomers typically classify starburst galaxies based on their most distinct observational characteristics. Some of the categorizations include Ultraluminous and Hyperluminous Infrared Galaxies. These galaxies are generally extremely dusty objects. The ultraviolet radiation produced by the obscured star-formation is absorbed by the dust and reradiated in the infrared spectrum at wavelengths of around 100 micrometers [Starburst galaxy].

SDSS J1148 + 5251 is one of the most distant quasar (z = 6.42) with light-travel distance 13 billion light-years. It has been extensively studied at many wavelengths (see [45] and references therein). It is a Hyperluminous Infrared Galaxy [$L_{IR} = (2-3)\times10^{13} L_\odot$] with the observed maximum rest frame wavelength about 60 microns. A conversion of L_{IR} into star formation rate gives 3500 - 5000 $M_\odot$/yr. Its' dynamical mass is about $5\times10^{10} M_\odot$, dust mass is $(1-4)\times10^8 M_\odot$ and dust temperature 50 - 60 K. In words of F. Galliano, *et al.* *"It challenges our understanding of dust formation in extreme environments: how could such a high mass of dust have formed in only a few 100 Myr?"* [45]

WUM: According to the Model, "dust particles" are Bose-Einstein Condensate (BEC) drops of dineutrinos whose mass is about Planck mass M_P and their temperature is around 29 K in the present epoch [3]. The temperature of BEC drops is decreasing in time proportional to the fourth root of the cosmological time $\propto \tau^{-1/4}$. The ages of the World are about 14.2 and of the SDSS J1148 + 5251 about 1.2 billion years respectively. Then the BEC drops temperature at that time was about 54 K that is in good agreement with the measured value. In our opinion, BEC drops with masses about Planck mass are the smallest building blocks that participate in Macroobjects creation [3]. Observed Ultraluminous (ULIRG) and Hyperluminous Infrared Galaxies (HLIRG) are in fact huge clouds of BEC drops of dineutrinos which are in fact Cradles of Macroobjects.

Chao-Wei Tsai, *et al.* present 20 highly obscured Wide-field Infrared Survey Explorer (WISE)-selected galaxies with bolometric luminosities $L_{bol} > 10^{14} L_\odot$, including five with infrared luminosities $L_{IR} \equiv L_{(8-1000\,\mu\text{m})} > 10^{14} L_\odot$. WISE J224607.57-052635.0 is an Extremely Luminous Infrared Galaxy which, in 2015, was announced as the most luminous galaxy in Universe ($L = 3.49\times10^{14} L_\odot$).The light emitted by the quasar with mass $\sim 10^{10} M_\odot$ is converted to infrared rays by the galaxy's dust. The galaxy releases 10,000 times more energy than the Milky Way galaxy, although WISE J224607.57-052635.0 is smaller than the Milky Way galaxy. It has a light-travel distance of 12.5 billion light-years away from Earth [46].

WUM: In our opinion, ULIRG and HLIRG are in fact active Cores of galaxy clusters which have the maximum mass of about $1.2\times10^{41}\,\text{kg}$ in present epoch (see **Table 1**). Mass of galaxy clusters is increasing in time $\propto\tau^{3/2}$. The age of WISE J224607.57-052635.0 is about 1.7 billion years. Then the maximum mass of the galaxy cluster Core at that time was about $0.5\times10^{40}\,\text{kg}$ that is in good agreement with the evaluated mass. In frames of the developed picture, much higher energy released by WISE J224607.57-052635.0 relatively to the Milky Way galaxy has a reasonable explanation.

The archetype starburst galaxy Arp 220 appears to be a single, odd-looking galaxy, but is in fact a nearby example of the aftermath of a collision between two spiral galaxies with the cores of the parent galaxies 1200 light-years apart. Observations with NASA's Chandra X-ray Observatory have also revealed X-rays in the range 2 - 10 keV coming from both cores [47]. The collision, which began about 700 million years ago, has sparked a cracking burst of star formation, resulting in about 200 huge star clusters in a packed, dusty region about 5000 light-years across [48]. N. Z. Scoville, *et al.* inferred a dynamical mass of $(3-6)\times10^{10}M_{\odot}$ within $r\cong1.5\,\text{kpc}$ [49].

It is an Ultraluminous Infrared Galaxy (ULIRG), about 250 million light-years away from Earth. Almost 99% of its total energy output is in the infrared with total luminosity of $\sim2\times10^{12}L_{\odot}$. IRAS observations of the galaxy Arp 220 give the following data for average Flux Densities (*FD*) at different wavelengths: $FD_{12\,\mu\text{m}}=0.48$; $FD_{25\,\mu\text{m}}=8.5$; $FD_{60\,\mu\text{m}}=124$; $FD_{100\,\mu\text{m}}=149\,\text{Jy}$. It is extremely luminous in the Far-infrared [50].

The heart of Arp 220 is highly obscured by dust that can't be penetrated by the radiation with visible wavelengths. But radio waves can travel through such a dense environment to reach telescopes on Earth. F. Batejat, *et al.* have resolved for the first time, 11 of the 17 detected sources at 2, 8, and 3.6 cm wavelength, and have spotted a record-breaking seven supernovae all found at the same time. Astronomers estimate that the Milky Way galaxy sees only a single supernova every hundred year, on average [51].

Through analysis of 7.5 years of Fermi/LAT observations, Fang-Kun Peng, *et al.* found high-energy gamma-ray emission in the range 0.2 - 100 GeV from Arp 220. This is the first-time detection of GeV emission from an ULIRG. There is a clear positive empirical relation between the γ-ray luminosity $L_{0.1-100\,\text{GeV}}$ and total infrared luminosity $L_{8-1000\,\mu\text{m}}$ and between the gamma-ray luminosity and radio luminosity [52].

WUM: The observed experimental results testify that Arp220 is the Core of galaxy cluster:

- Two spiral galaxies have already been created;

- There are about 200 huge star clusters in a packed, dusty region ~5,000 light-year across;
- A record-breaking seven supernovae all found at the same time;
- A dynamical mass of $(3-6)\times10^{10}M_{\odot}$ within $r\cong1.5\,\text{kpc}$ corresponds to the maximum mass of the galaxy cluster Core with a sterile neutrinos shell ~ 10^{41} kg (see **Table 1**);
- Maximum flux density of Far-infrared radiation at wavelength 100 μm can be explained by BEC drops of dineutrinos;
- Gamma-rays in the range 2 - 10 keV coming from both spiral galaxies are the result of sterile neutrinos annihilation with mass 3.7 keV;
- High-energy gamma-ray emission in the range 0.2 - 100 GeV is the consequence of neutralinos and WIMPs annihilation in stellar formation processes.

Far-infrared emission (FIR) of the sky is generally thought to originate mainly in cold dust grains distributed in space. The FIR emission of galaxy clusters may be considered therefore as a tracer of the dust constituent of the intracluster medium. Based on IRAS and COBE/DIRBE sky surveys it was found excess FIR emission from the sky area occupied by galaxy cluster ZW5897. Very good positional and extensional coincidence between infrared source and ZW5897 may suggest intracluster origin of the emission which has the highest intensities in the 100, 140 and 240 μm bands. B. Wszołek studied the distribution of stars and galaxies in the cluster area and found that a foreground obscuring cloud, overlapping accidentally the distant cluster ZW5897, may be responsible for some part of the detected FIR emission [53].

WUM: According to the Model, FIR emission with the highest intensities in the 100, 140 and 240 μm bands is originating in the intracluster medium of ZW5897 filled with BEC drops of dineutrinos.

As the conclusion: ULIRG and HLIRG are in fact Starburst Galaxy Clusters.

11. Gravitational Waves

Some cosmological problems like the dark energy and dark matter problems could be solved through extended theories of gravity. In fact, extended gravity is also connected with the recent detections of gravitational waves by the LIGO collaboration [54]. An important work on these issues is published in 2009 [55].

Galaxy/stellar formation in a packed, dense environment of ULIRG and HLIRG can produce many interesting objects and exotic binary systems. Dynamical interactions in Active Galaxy Clusters (AGC) can eject a lot of compact binary systems that could be potential sources of Gravitational Waves (GWs). In frames of WUM, it can be binaries of:

- Neutron stars;
- WIMP stars;
- Neutralino stars;
- White dwarfs

with masses about $M_{\odot}$ which are Cores of stellar systems. It can be also binaries of compact DIRAC stars with shells made of Dirac's monopoles. They have masses up to $10^{3}M_{\odot}$ and sizes about the Earth size (see **Table 1**). DIRAC stars are Cores of stellar clusters in WUM. Binaries of them are the most interesting, because they have masses in the range of the masses of compact binary objects responsible for the observed GWs (30 and up to 60 solar masses [54]).

Due to the packed, dense environment of ULIRG and HLIRG DIRACs binaries can have short gravitational wave merger times. Their merger generates GWs which can penetrate through such a dense environment. The heart of ULIRG and HLIRG is highly obscured by BEC drops that can't be penetrated by radiation with visible wavelengths. In our opinion, a merger of compact DIRAC stars inside of Active Galaxy Clusters like Ultraluminous and Hyperluminous Infrared Galaxies can be a source of Gravitational waves.

Transient Astrophysics is a rapidly growing field, now operating across all wavelengths from gamma-rays to radio waves. Hypersphere World-Universe Model can serve as a basis for Transient Astrophysics.

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