The diffierence between the column densities $S_{\rm NFW}, S_{\rm Burkert}$ and $s_{\rm ISO}$ turns out to be less than 10%. Then

$$\frac{S_{\rm NFW}(r_{\rm s})}{S_{\rm burkert}(1.6r_0)} \approx 0.98. \tag{10}$$

$$S_{\rm NFW}(r_{\rm s}) \approx 0.98 S_{\rm Burkert}(1.6r_0) \approx 0.91 S_{\rm ISO}(6r_{\rm c}) \approx 1.89 r_0 \rho_0.$$

In Fig. 2, the thick-solid and dashed black lines represent the value of $\log \mu_0 D = 2.15 \pm 0.2$. The cireles correspond to dark matter surface densities obtained using the quoted sample and with differennt methods. The filled symbols represent the averged estimates of $\log \mu_0 D$ when a galaxy was present in more than one soure. The thin solid line represents the result of our model for the surface density when considering galaxies made of only dark matter. The dashed light grey line denotes the surface density obtianed when taking into account all effects considered. For masses lower than $\approx 5\times10^{10} M_{\rm sun}$ and magnitudes brighter than $M_{\rm B} \approx = -1.4$, the surface density is constant. However, a systematic change of the awewege column density $\rho_0 r_o$ as a function of the object's mass is clearly present for langer masses. Such results make, therefore, us safely argue against the constancy or universality of the surface density claimed by Ref. [3] .

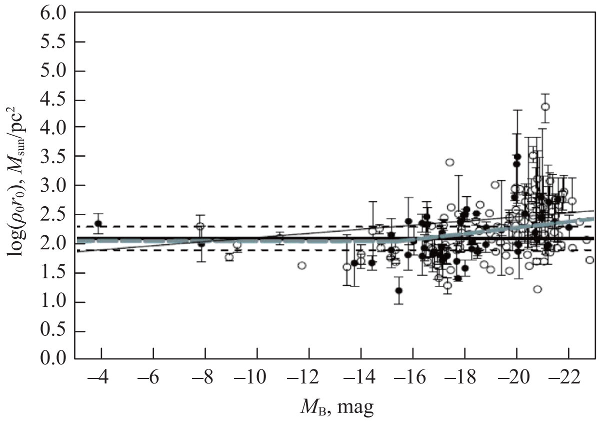

Fig. 2 $\rho_0 r_0$ in units of $M_{\rm sun}/pc^2$ as a function of galaxy magnitude for different galaxies and Hubble types.

References

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1 - 9 Higgs Portal Dark Matter Models*

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Higgs Portal dark matter have been supposed due to the two facts that dark matter has a gravitational force and has no strong interaction and electromagnetic interaction. A natural logic is the possibility of hiding dark matter. That is, the dark matter does not have the interaction of standard model. Dark matter may be hidden sector. The standard model particles are in the visible sector. The Higgs sector of the Standard Model enjoys a special feature that it can couple to the hidden sector at the renormalizable level. Ref.[1] has discussed the relationship between the standard model and hidden sector. Let H be Higgs field and ϕ, be the "hidden Higgs field" in hidden sector. There are a "Higgs portal" interaction term between H and ϕ as

$$V_{\rm portal} = \lambda_{h\phi} H^+ H \phi^+ \phi. \tag{1}$$

Here the field ϕ of hidden sector corresponds to the gauge symmetry breaking in hidden sector. It is assumed that the hidden sector gives the $S(1)$ or $SU(N)$ gauge symmetry, the matter field of standard model act naturally as the WIMP type matter field. In fact, the matter field and particles of standard model by weak coupling. To describe the standard model of dark matter the lagrangian method has been extended to increase the field in hidden sector lagrangian in standard model, then consider Higgs portal and discrete symmetres.

Scalar dark matter model[2]:Consider a simple field ϕ, the all lagrangian can be written

$$\mathcal{L} = \mathcal{L}_{\rm SM} + \mathcal{L}_{\rm Hidden} + \mathcal{L}_{\rm Portal}, \tag{2}$$

where the $\mathcal{L}_{\rm SM}$ is the lagrangian of standard model and

$$\mathcal{L}_{\rm Hidden} = \frac{1}{2}\partial_\mu \phi \partial^\mu \phi - \frac{m_0^2}{2}\phi^2 - \frac{\lambda_\phi}{4}\phi^4 \tag{3}$$

is the lagrangian of scalar field in hidden sector. For single scalar field, the single field ϕ is just the scalar field of dark matter. Here, H is a Higgs double state. There exists a discrete symmetry: Lagrangian invariant under $\phi \to -\phi$. The coupling betwwen scalar field and standard model is realized by Higgs Boson, and the interaction is determined by $\lambda_{h\phi}$. By using the method of spontaneous breaking of vacuum, and setting $\sqrt{2}H^+ = (h,0)$, (where h is real). One obtain the scalar potential as

$$V = \frac{1}{2}(m_0^2 + \lambda_{h\phi} v_{EW}^2)\phi^2 + \frac{\lambda_\phi}{4}\phi^4$$

$$+\lambda_{h\phi} v_{EW}\phi^2 h + \frac{\lambda_{h\phi}}{2}\phi^2 h^2, \tag{4}$$

where $v_{\mathrm{EW}} = 246GeV$ is the parameter of standard model and Higgs mass $m_h^2 = \lambda_\phi v_{\mathrm{EWge}}^2$, scalar field ϕ mass is $m_\phi^2 = m_0^2 + \lambda_{h\phi} v_{\mathrm{EW}}^2$. m_ϕ may range from a few GeV to several hundred GeV. Therefore, the scalar field in the hidden sector may be a candidat of dark matter.

Massive gauge field as vector Dark matter[2]**:** An Abelian gauge field in hidden provides the simplest example of the vector dark maatter endowed with a natural Z_2 symmetry. In this case, the Z_2 corresponds to the charge conjugation symmetry.

Consider a $U(1)$ gauge theory with a single charged scalar field ϕ,

$$\mathcal{L}_{\mathrm{Hidden}} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + (D_\mu\phi)^+ D^\mu\phi - V(\phi), \tag{5}$$

where $F_{\mu\nu}$ is the field strength tensor of the gauge field A_μ and $V(\phi)$ is the scalar potential. One takes the charge of ϕ to be $+1/2$ and supposes the minimum of the VEV of the scalar potential is $<\phi> = 1/\sqrt{2}\tilde{v}$. The imaginary part of ϕ gets eaten by the gauge field which now acquires the mass $m_A = \tilde{g}\tilde{v}/2$, where $\tilde{g}$ is the gauge coupling. The real part of ϕ remains as a degree of freedom denoted by ρ, after regularization, one has $\phi = 1/\sqrt{2}(\rho + \tilde{v})$ and gets the following gauge-scalar interactions:

$$\Delta\mathcal{L}_{\mathrm{s-g}} = \frac{\tilde{g}^2}{4}\tilde{v}\rho A_\mu A^\mu + \frac{\tilde{g}^2}{8}\rho^2 A_\mu A^\mu. \tag{6}$$

The system possesses the Z_2 symmetry

$$A_\mu \to -A_\mu, \tag{7}$$

which is the usual charge conjugation symmetry. In terms of the original scalalr field, this symmetry acts as $\phi \to \phi^*$ and $A_\mu \to -A_\mu$, which is preserved by both the Lagrangian and the vacuum. The Z_2 makes the massive gauge field stable. Interactions with the visible sector proceed thhroug the Higgs portal coupling

$$\mathcal{L}_{\mathrm{portal}} = -\lambda_{h\phi}|H|^2|\phi|^2, \tag{8}$$

which also leads to the Higgs mixing with ρ. In the unitary gauge, the Higgs field is given by $H^T = (0, v+h)/\sqrt{2})$. The field ρ and h are then to be expressed in terms of the mass eigenstates $h_{1,2}$ as follows:

$$\rho = -h_1 \sin\theta + h_2 \cos\theta,$$

$$h = h_1 \cos\theta + h_2 \sin\theta, \tag{9}$$

where the mixing angle θ is the Higgs mixing angle, constrained by various experiments. One may identify h_1 with the 125 GeV Higgs. Let us now discuss the main phenomenological features of this scenario. All the relevant scattering processes, including Dakr matter annihilation and nucleon scattering, proceed through h_1 and h_2 exchange. The dark matter-nucleon interaction cross section is given by Ref. [2]

$$\sigma_{\mathrm{A-N}}^{\mathrm{SI}} = \frac{g^2\tilde{g}^2}{16\pi}\frac{m_{\mathrm{N}}^2\mu_{\mathrm{AN}}^2 f_{\mathrm{N}}^2}{m_W^2}\frac{(m_{h_2}^2 - m_{h_1}^2)^2 \sin^2\theta\cos^2\theta}{m_{h_1}^4 m_{h_2}^4} \tag{10}$$

where m_{N} is the nucleon mass, $\mu_{\mathrm{AN}} = m_{\mathrm{A}}m_{\mathrm{N}}/(m_{\mathrm{A}} + m_{\mathrm{N}})$ and $f_N = 0.3$ parametrizes the Higgs-Nucleon coupling.

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