SURU PRESENTATION:

Updated Constraints

On Asteroid-Mass Primordial Black Holes

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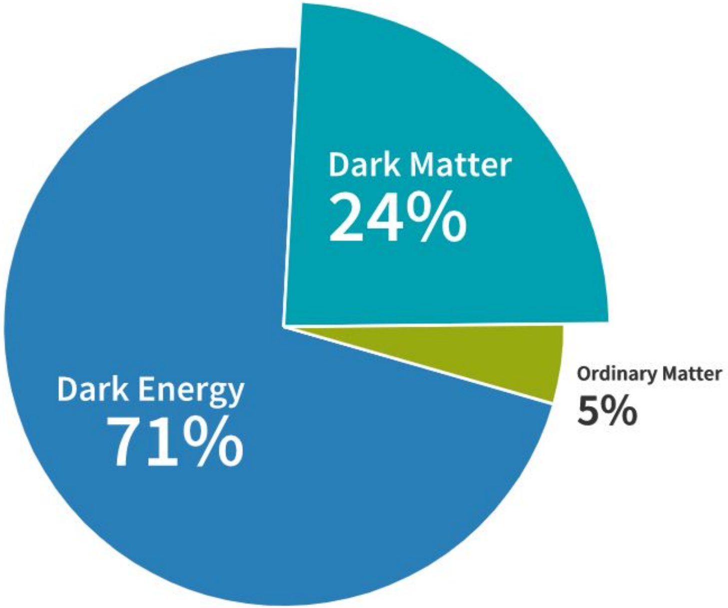
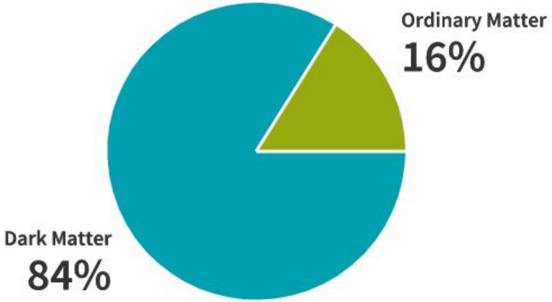
Why Does Dark Matter (DM) Matter?

Breakdown of Energy Density of Universe & Composition of Matter



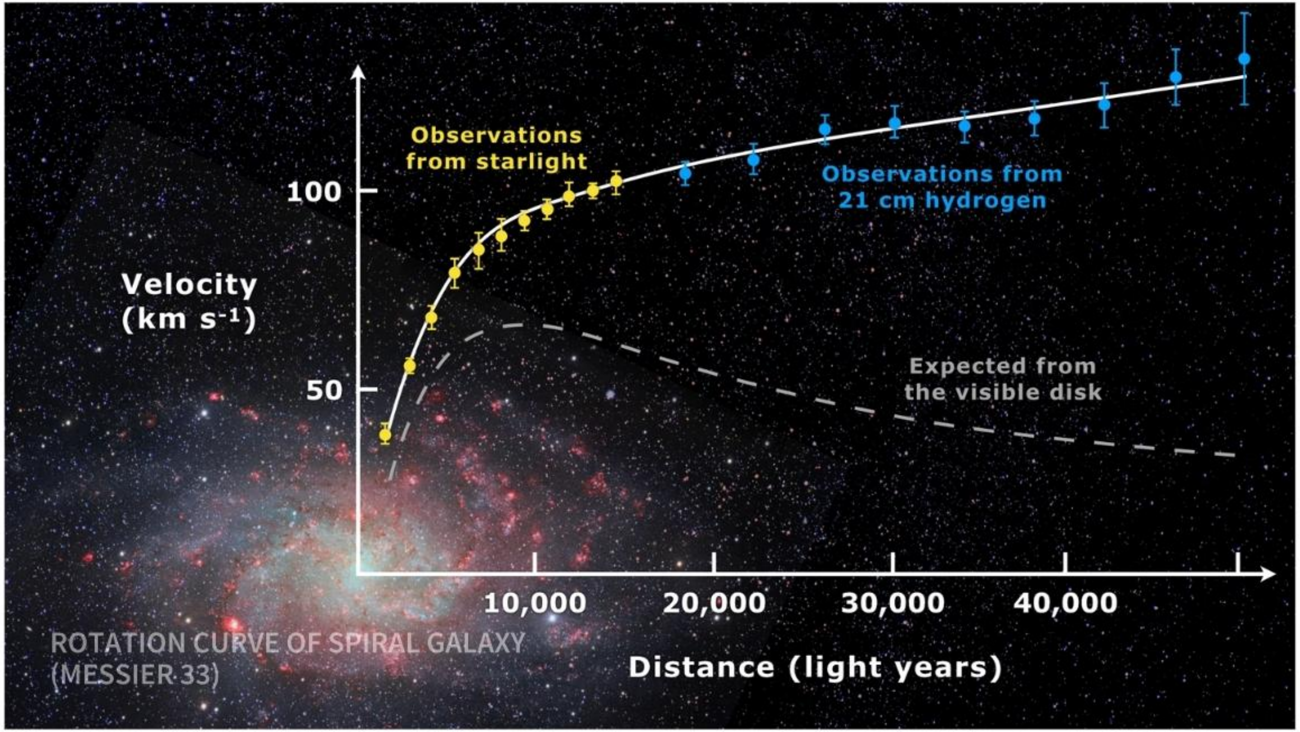
Matter Makeup Only:



https://map.gsfc.nasa.gov/media/121236/index.html

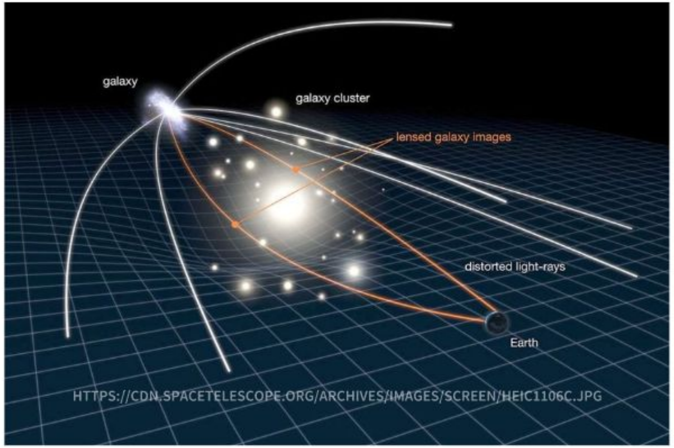
Discrepancies in Velocity

Why We Postulate the Existence of Non-luminous Matter



Primordial Black Holes (PBHs) as DM Candidates

& Microlensing Event Detection



Origin of PBHs

Hypothetical black hole type formed in early universe

Cosmic inflation period generated patches of overdensity (quantum fluctuations)

Does not rely on existence of exotic particles

Detection of PBHs

Gravitational wave detection (LIGO, VIRGO)

Gravitational lensing events

Finite Size Effects

Regime in which FSEs take over:

When the Einstein radii of the PBHs becomes ≤ size of source star

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Corrections to constraints become larger as stellar sizes become significant for low mass range of PBHs

$$\frac{\theta_S}{\theta_E} = \frac{R_S d_L}{R_E d_S} = R_S \left(\frac{x}{1-x} \right)^{1/2}, \tag{11}$$

The finite size effects also weaken the constraints for intermediate mass black holes. The finite size effects are greatest when the lensing PBH is close to the source star. That is, as d_L approaches d_S, the finite size effect washes out magnification for all masses of PBH. This is also the region where the DM density contribution from M31 in Eq. (10) is the greatest, leading to a noticeable weakening of the constraints for all but the high mass region of the relevant parameter space.

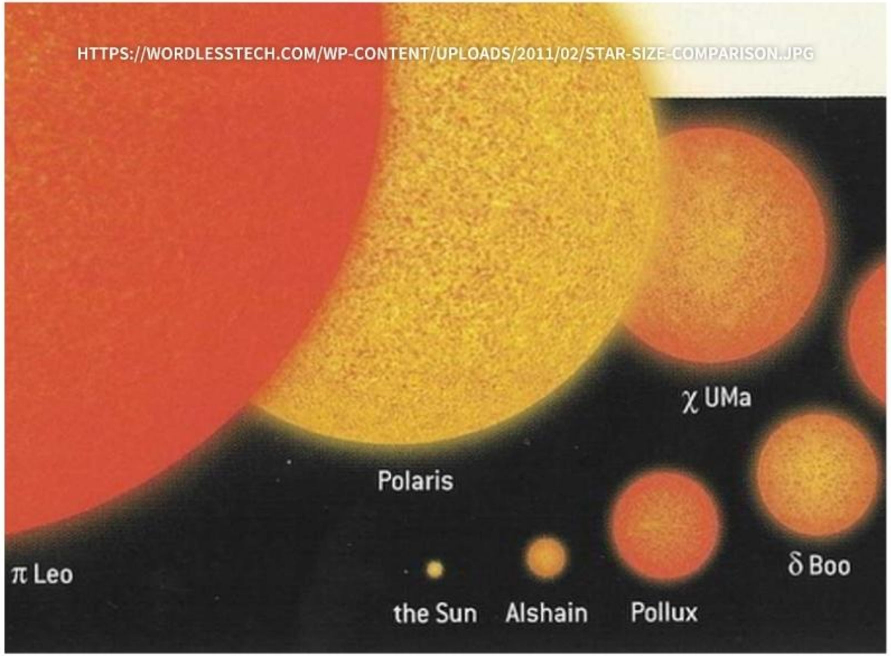
Subaru/HSC Constraints on PBH Microlensing ?

Microlensing constraints on primordial black holes with the Subaru/HSC Andromeda observation

Hiroko Niikura[1,2], Masahiro Takada[1], Naoki Yasuda[1], Robert H. Lupton[3], Takahiro Sumi[4], Surhud More[1], Toshiki Kurita[1,2], Sunao Sugiyama[1,2], Anupreeta More[1], Masamune Oguri[1,2,5], Masashi Chiba[6]

5. DISCUSSION

RGB stars have much greater radius than that of main sequence stars, where the finite source size effect is more significant. Here we employ a solar radius ($R_\odot \simeq 6.96 \times 10^{10}$ cm) for all source stars for simplicity, assuming that the upper bound is mainly from the microlensing for main sequence stars, rather than for RGB stars [31]. We followed [37] to re-estimate the event rates of PBHs microlensing taking into account the finite source size effect. Fig. 24 shows that the finite source size effect lowers the event rate, compared to Fig. 8. In particular the effect is greater for PBHs of smaller mass scales and in the M31 halo region.



Oversimplification, assumption was incorrect.

Modeling Andromeda's (M31) Population of Stars

Obtaining Radii from Luminosities & Temperatures

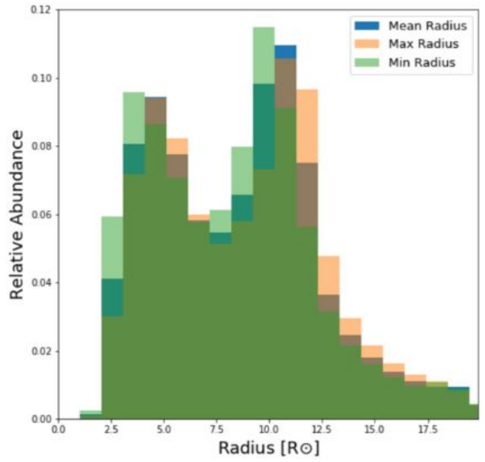
Take data from PHAT (Panchromatic Hubble Andromeda Treasury) survey, available publicly online

Select individual stars which meet threshold criteria, allowing us to subsequently manipulate data values

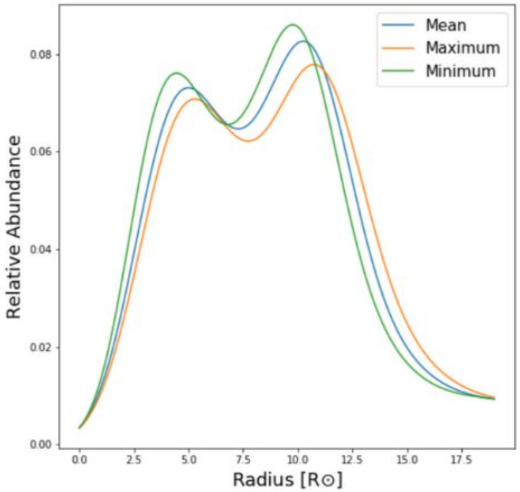
Compare to synthetic star catalogue (MIST): obtain histogram of stellar population distribution

Stellar Population Distribution of M31

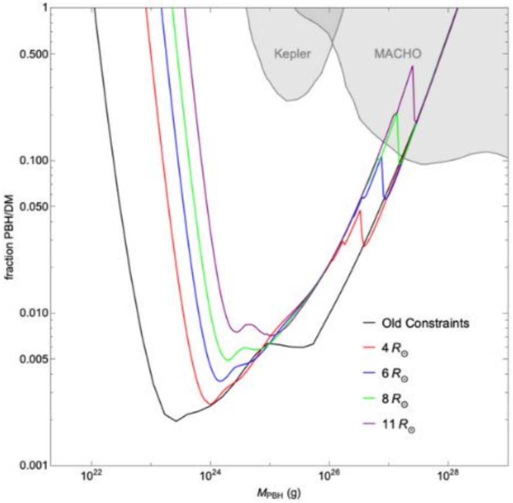
& Subsequent “Event Rate” Findings



Binned distribution for size of stars contributing to HSC constraints on PBH



Population of stars in M31 which could have microlensing light curves resolvable by HSC survey



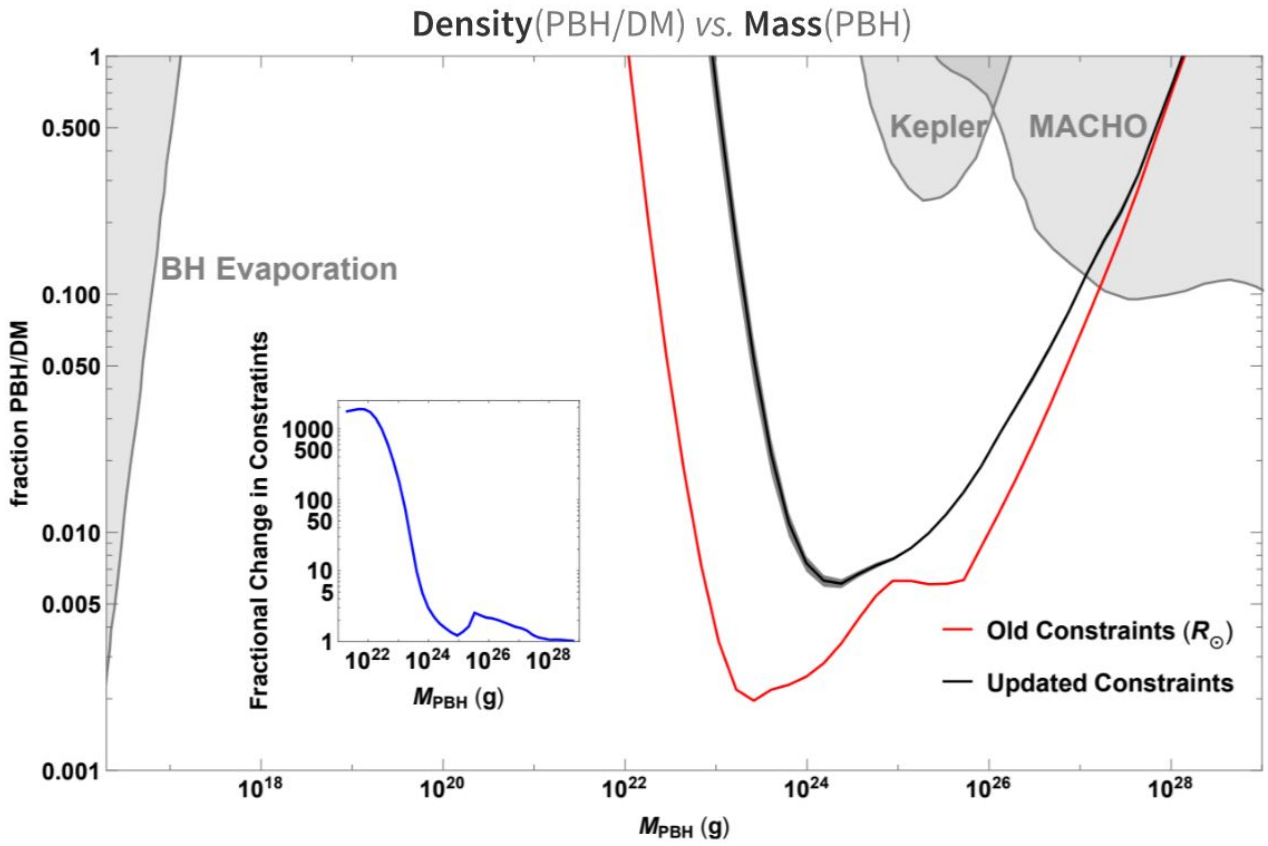
Constraints for example individual radii of a source star

Differential Event Rate

for microlensing of a single star by a PBH:

IT'S NOT MAGIC, IT'S CALCULUS!

$$\frac{d\Gamma_{PBH}}{d\hat{t}} = 2\frac{\Omega_{PBH}}{\Omega_{DM}} \int_0^{d_s} dd_L \int_0^{U_T} du_{min} \frac{1}{\sqrt{u_T^2 - u_{min}^2}} \frac{\rho_{DM}(d_L)}{M_{PBH} v_c^2(d_L)} v^4 \exp\left[-\frac{v^2}{v_c^2(d_L)}\right], \tag{10}$$



Density(PBH/DM) vs. Mass(PBH)
fraction PBH/DM
1
0.500
0.100
0.050
0.010
0.005
0.001
10^{18}
10^{20}
10^{22}
10^{24}
10^{26}
10^{28}
M_{PBH} (g)
BH Evaporation
Kepler
MACHO
Old Constraints ($R_\odot$)
Updated Constraints
Fractional Change in Constratints
1000
500
100
50
10
5
1
10^{22}
10^{24}
10^{26}
10^{28}
M_{PBH} (g)

Acknowledgments

& Further Readings

Source 1

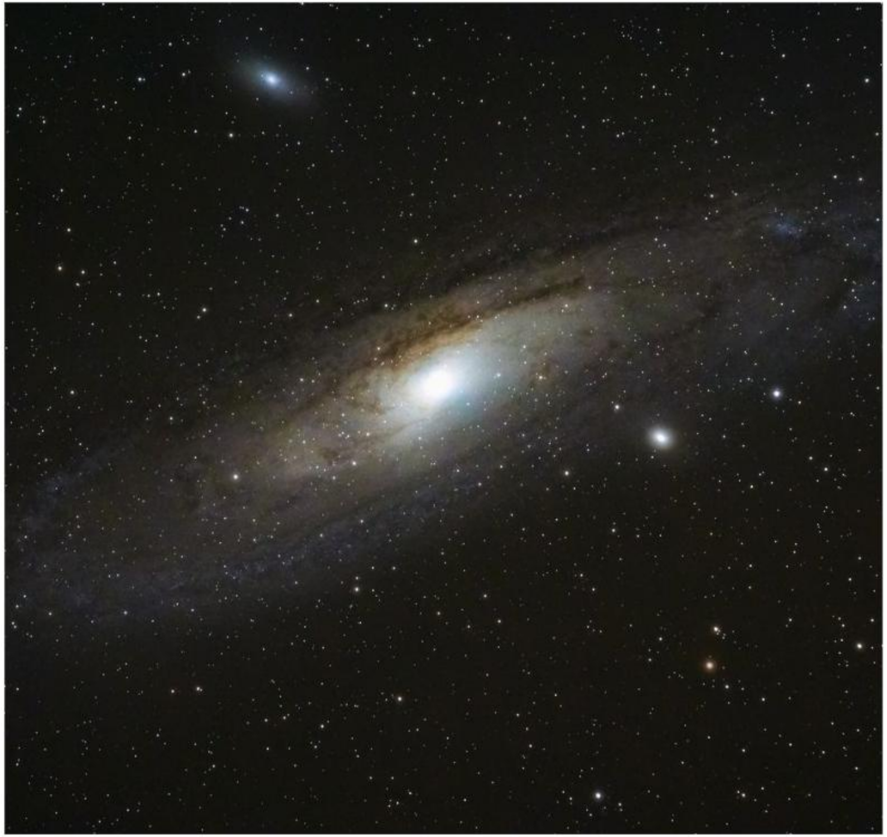
Smyth, N., Profumo, S., English, S., Jeltema, T., McKinnon, K., & Guhathakurta, P. (2019). Updated Constraints on Asteroid-Mass Primordial Black Holes as Dark Matter. ArXiv:1910.01285 [Astro-Ph, Physics:Hep-Th]. Retrieved from http://arxiv.org/abs/1910.01285

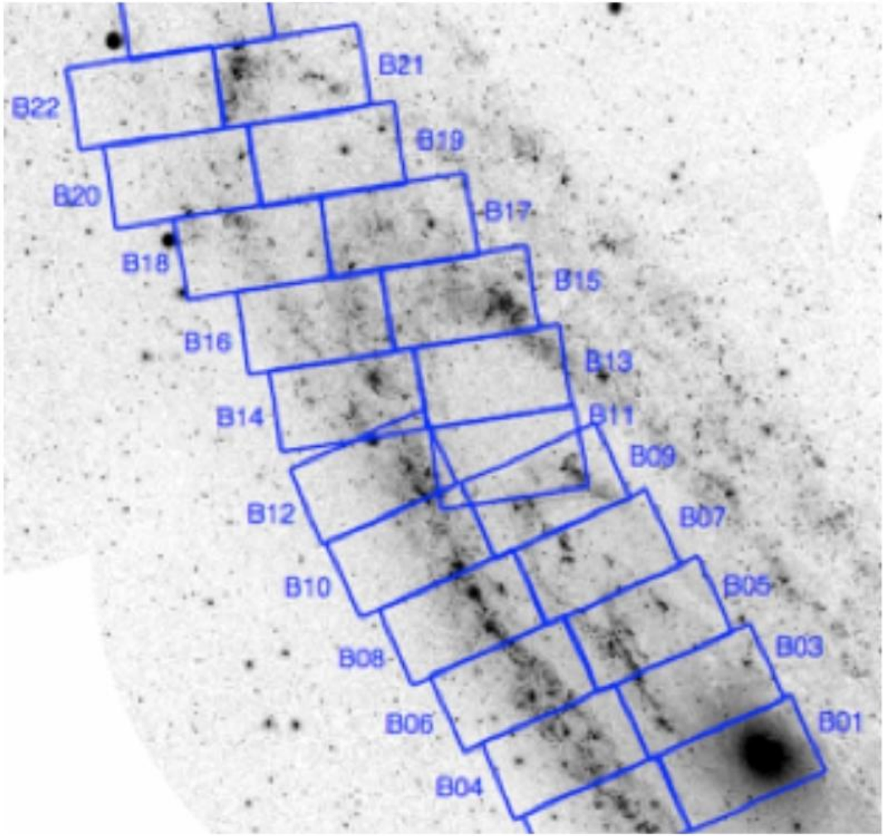
Source 2

Katz, A., Kopp, J., Sibiryakov, S., & Xue, W. (2018). Femtolensing by Dark Matter Revisited. Journal of Cosmology and Astroparticle Physics, 2018(12), 005–005. https://doi.org/10.1088/1475-7516/2018/12/005

Source 3

Niikura, H., Takada, M., Yasuda, N., Lupton, R. H., Sumi, T., More, S., … Chiba, M. (2019). Microlensing constraints on primordial black holes with the Subaru/HSC Andromeda observation. Nature Astronomy, 3(6), 524–534. https://doi.org/10.1038/s41550-019-0723-1





Organization of "bricks", we choose to exclude B06 & below due to bulge