Exoplanets as sub-GeV Dark Matter Detectors

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CCAPP

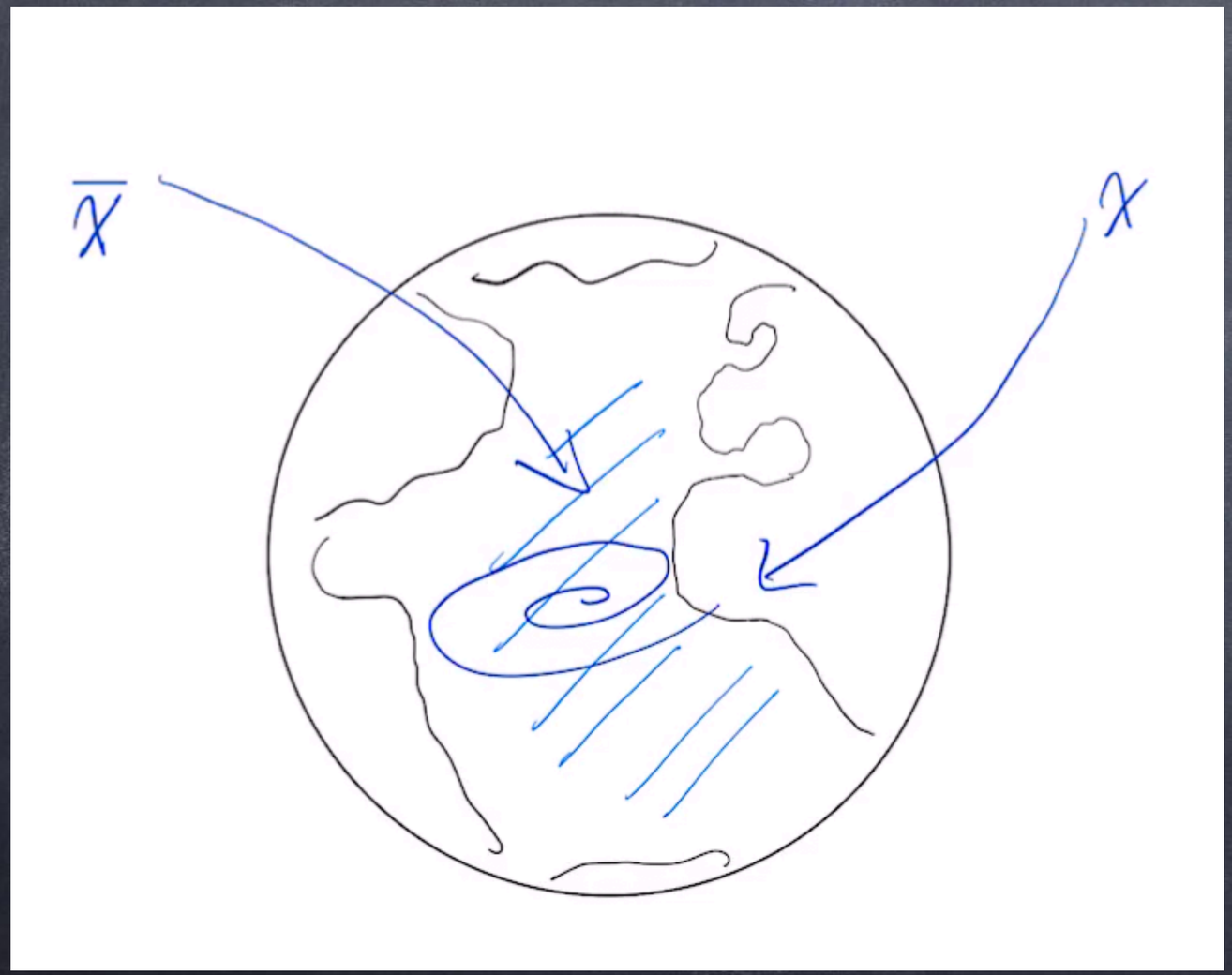
THE OHIO STATE UNIVERSITY

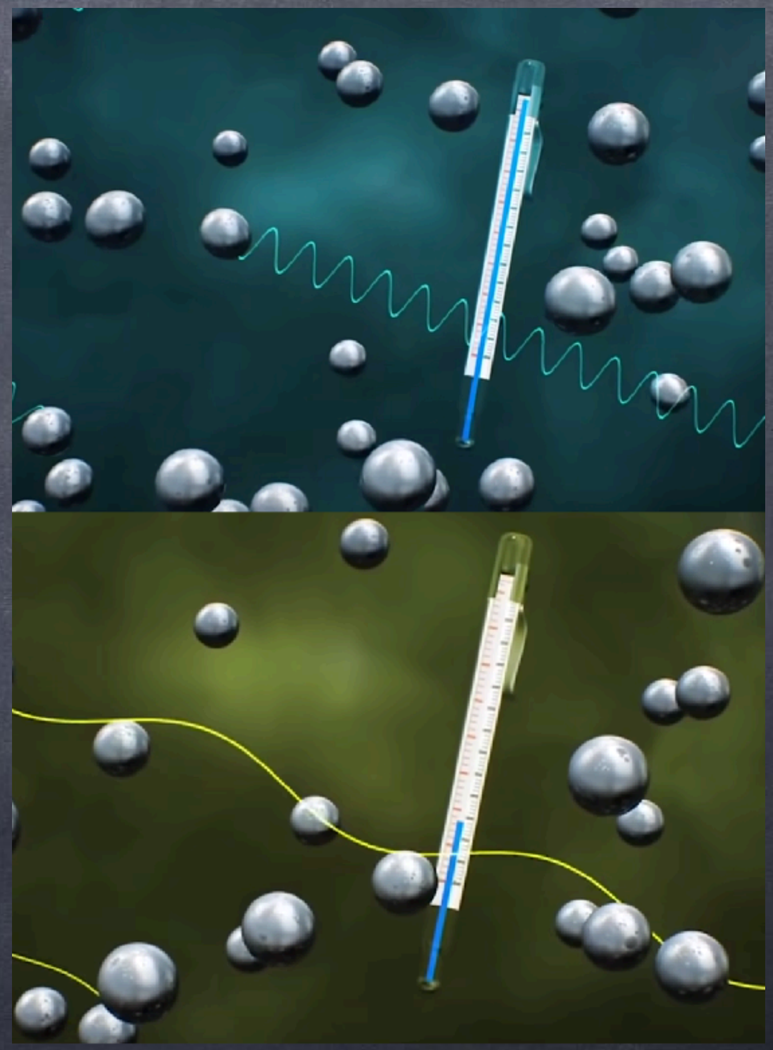
Pheno 2021 (Pittsburgh): 5/24/21

In collaboration with: Rebecca Leane (Stanford), Maria Benito (NICPB)

A New Astrophysical Search

Exoplanet Heating by Annihilating DM





Exoplanets are Exciting

PHYSICAL REVIEW LETTERS **126,** 161101 (2021)

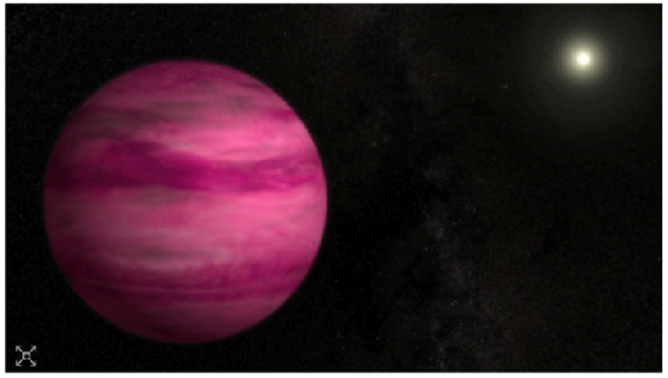
Editors' Suggestion | Featured in Physics

physicsworld

Magazine | Latest | People | In

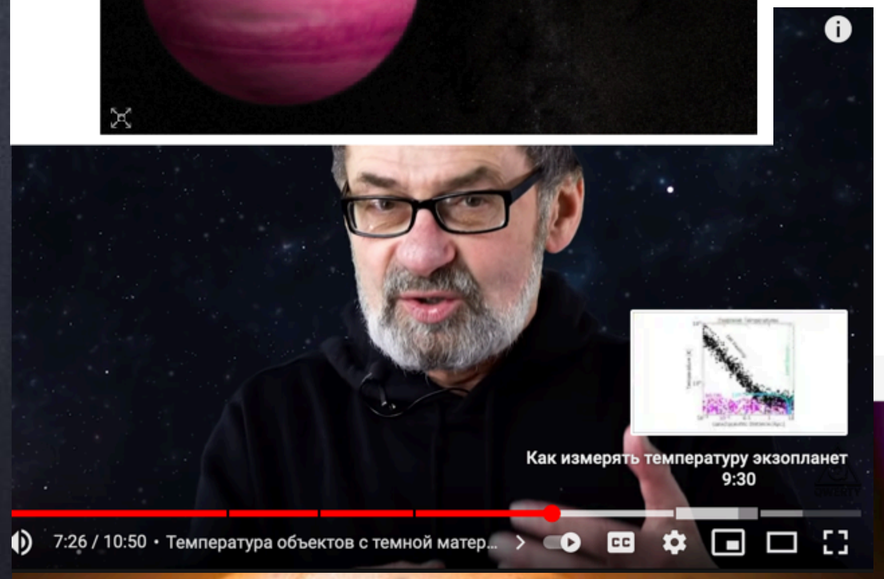
Exoplanets could be used as dark-matter detectors

08 May 2021



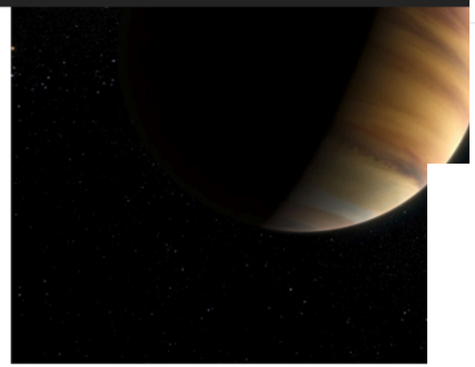
Exoplanets as Sub-GeV Dark Matter Detectors

Rebecca K. Leane[1,2,*] and Juri Smirnov[3,4,†]



Science

Contents | News | Car



Dark matter may lurk in the hearts of large exoplar

Dark matter could warm

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Where's the Dark Matter? Look for Suspiciously Warm Planets

Physicists calculated that these mysterious particles will betray their location with heat. To prove it, they'll need the most

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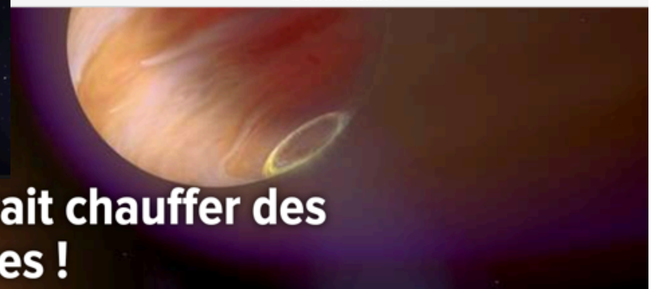
STELLAR CHEMISTRY

Using exoplanets as dark matter detectors

by Jeff Grabmeier for USU News

Columbus OH (SPX) Apr 20, 2021



DARK MATTER MIGHT HEAT EXOPLANETS ENOUGH TO MAKE THEM GLOW

BAD ASTRONOMY

We know that dark matter exists, but, irritatingly, we don't know what it is.

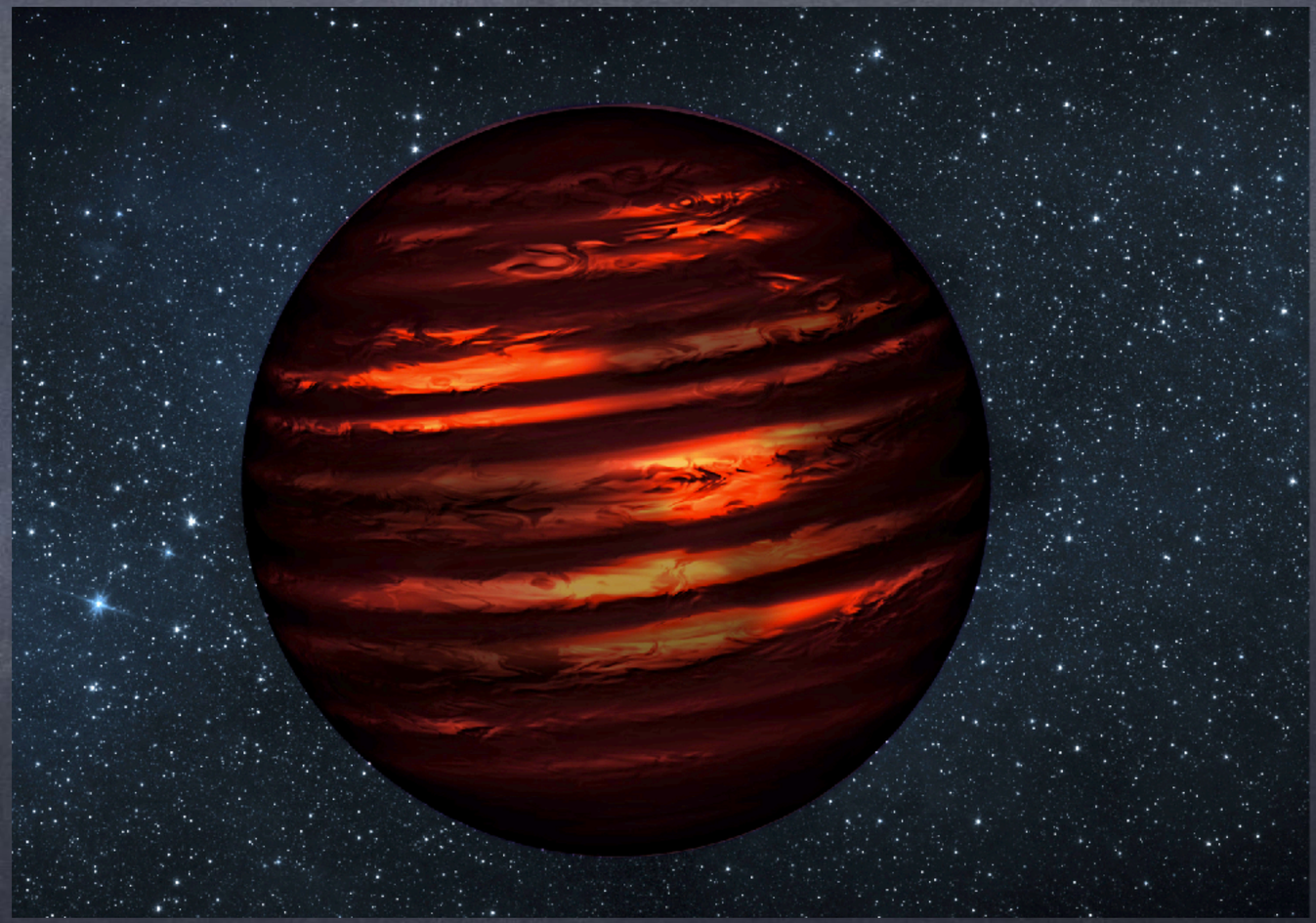
One way to figure that out is to look for signs of it here on Earth, using subatomic particle detectors. But a new idea just published in a scientific journal is that we need to go bigger. A lot

Contributed by

Phil Plait

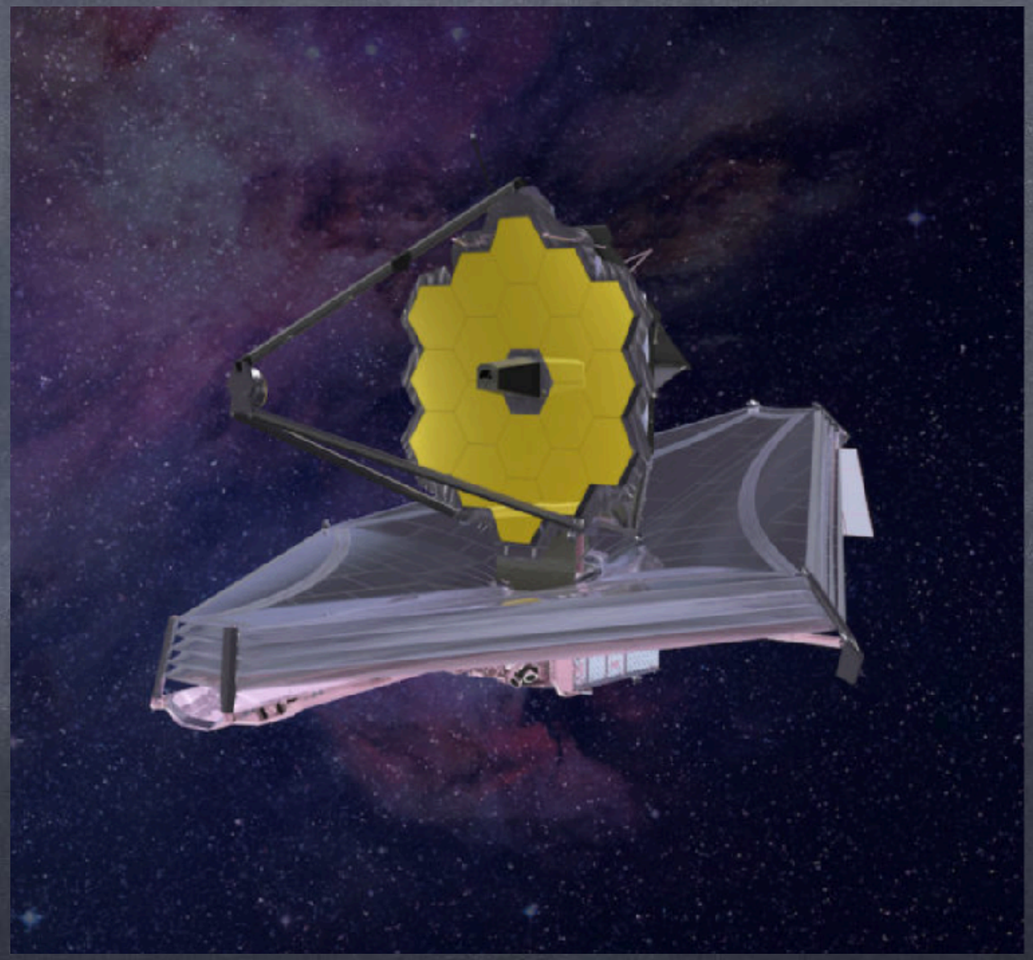
Some Facts

- 300 Billion expected Exoplanets in the Galaxy
- Estimated 100 Billion rogue planets
- 4324 Confirmed Exoplanets
- 5695 Candidates awaiting confirmation
- New Infrared Telescopes: JWST 2021 and Roman 2026

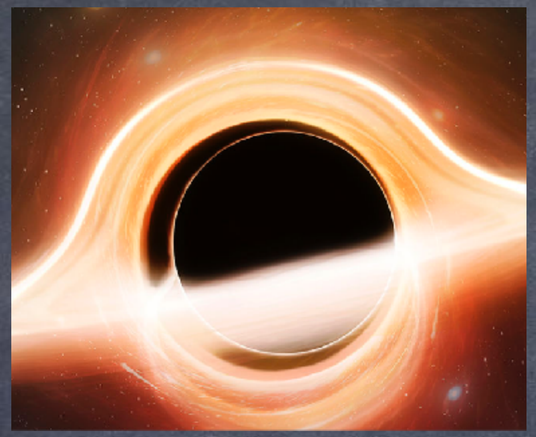


JWST 2021

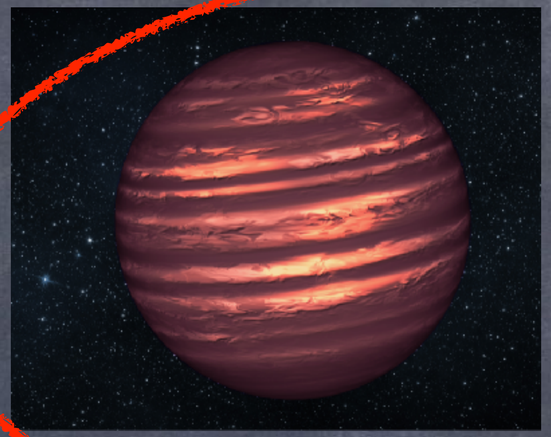
- 6.5 m Mirror diameter
- 18 Hexagonal Segments
- Near-Infrared Imager and Slitless Spectrometer (NIRISS) for T > 500 K
- Mid-Infrared Instrument (MIRI) for T : 100 - 500 K
- Launch: October 2021



Stuff in Space



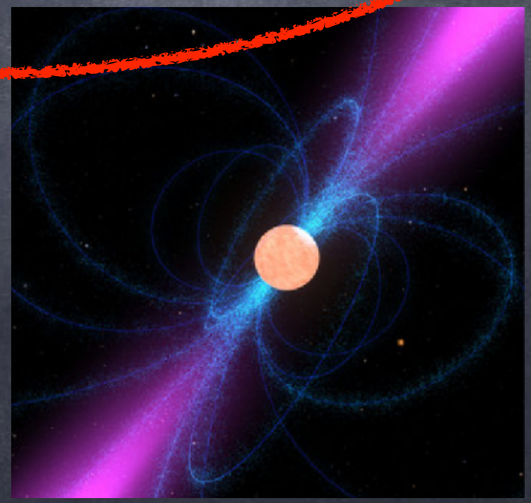
$M > \text{few } M_{Sol}$



$M = 10^{-1} - 10^{-2}\ M_{Sol}$

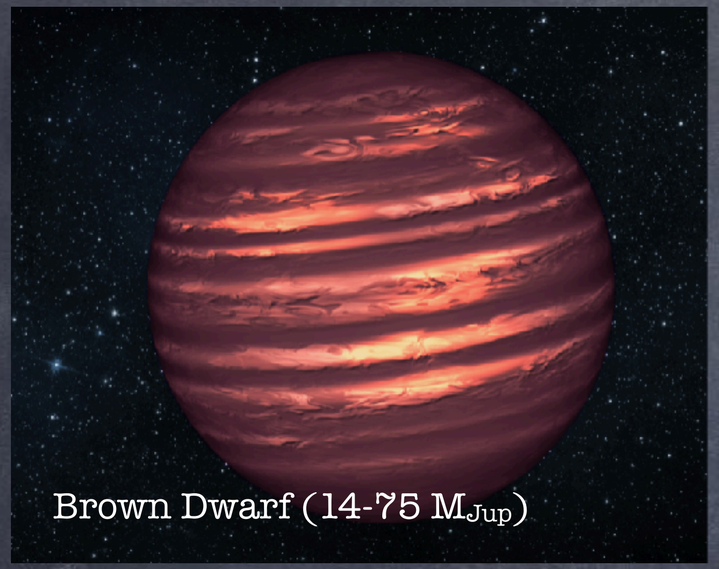
$M = 10^{-3}\ M_{Sol}$

$M = M_{Sol}$



$M = 1.4\ M_{Sol}$

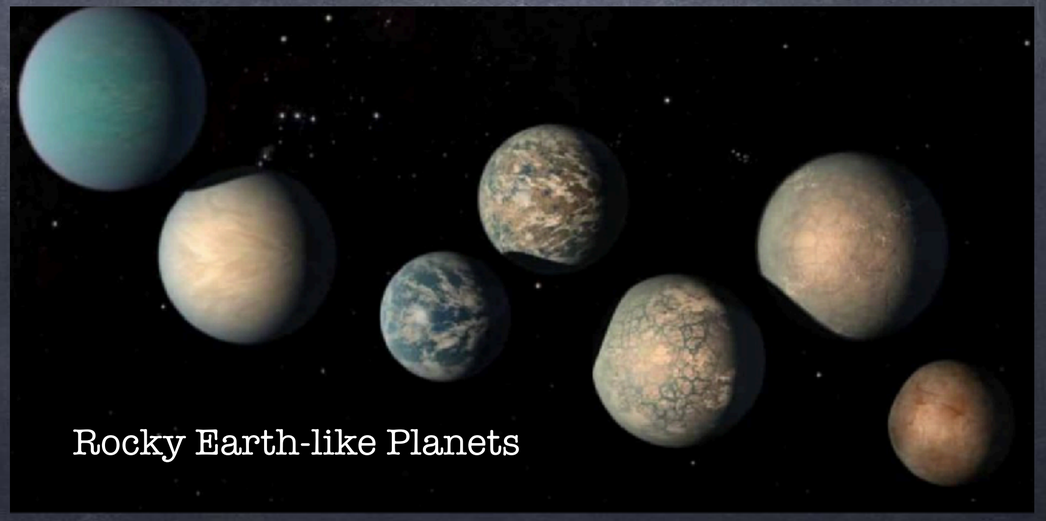
Exo-Menu


Brown Dwarf (14-75 M_{Jup})


Jovian Planets (1-13 M_{Jup})

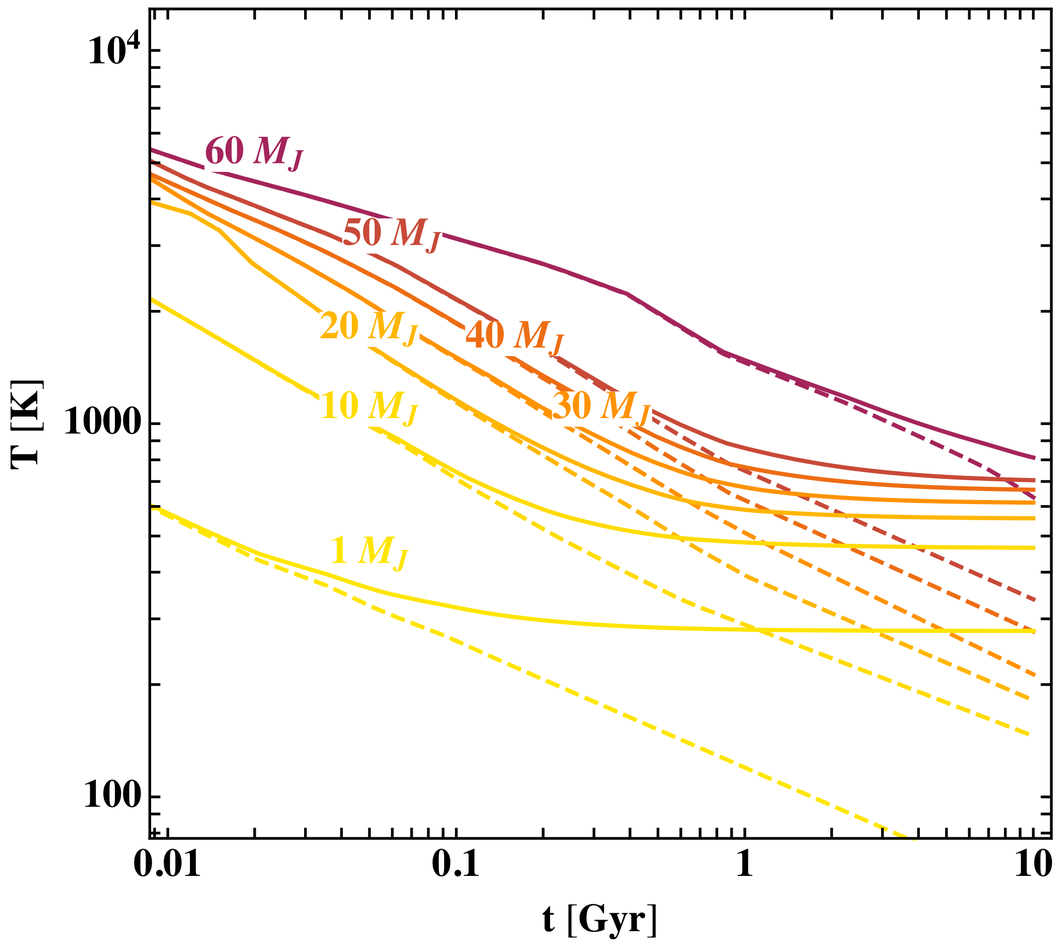
Best served old and cold


Rogues


Rocky Earth-like Planets

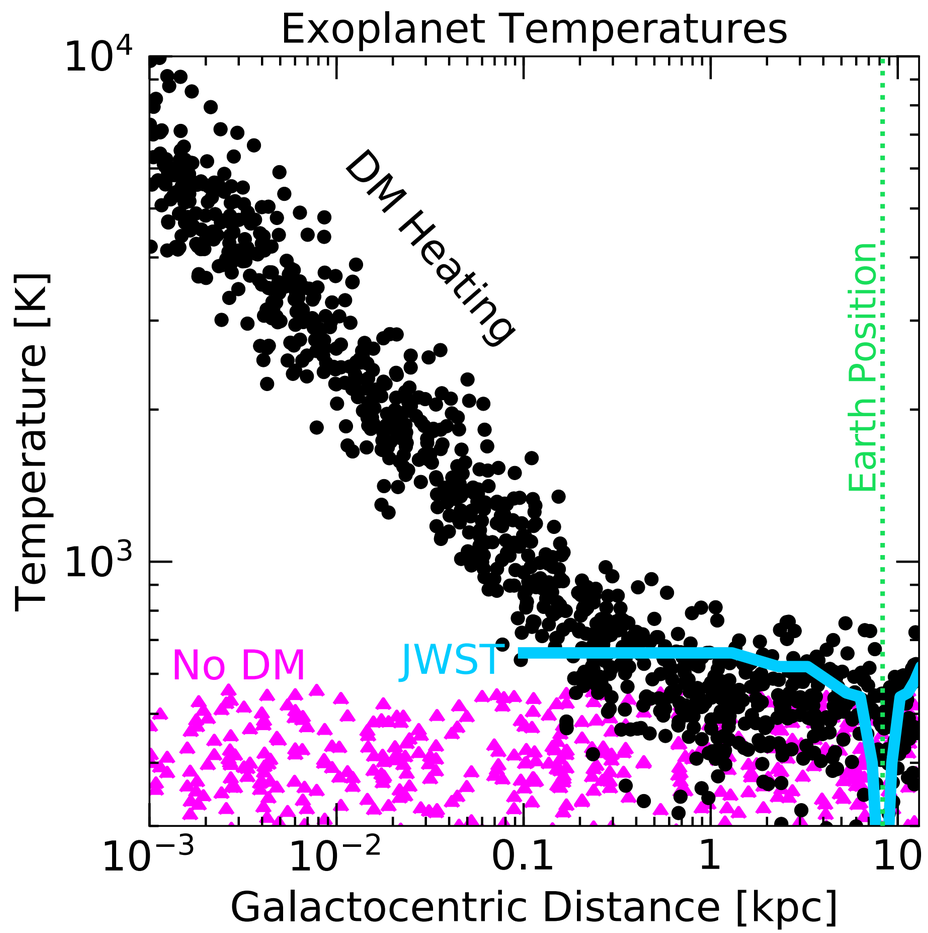
Search Strategies

Temperature Evolution



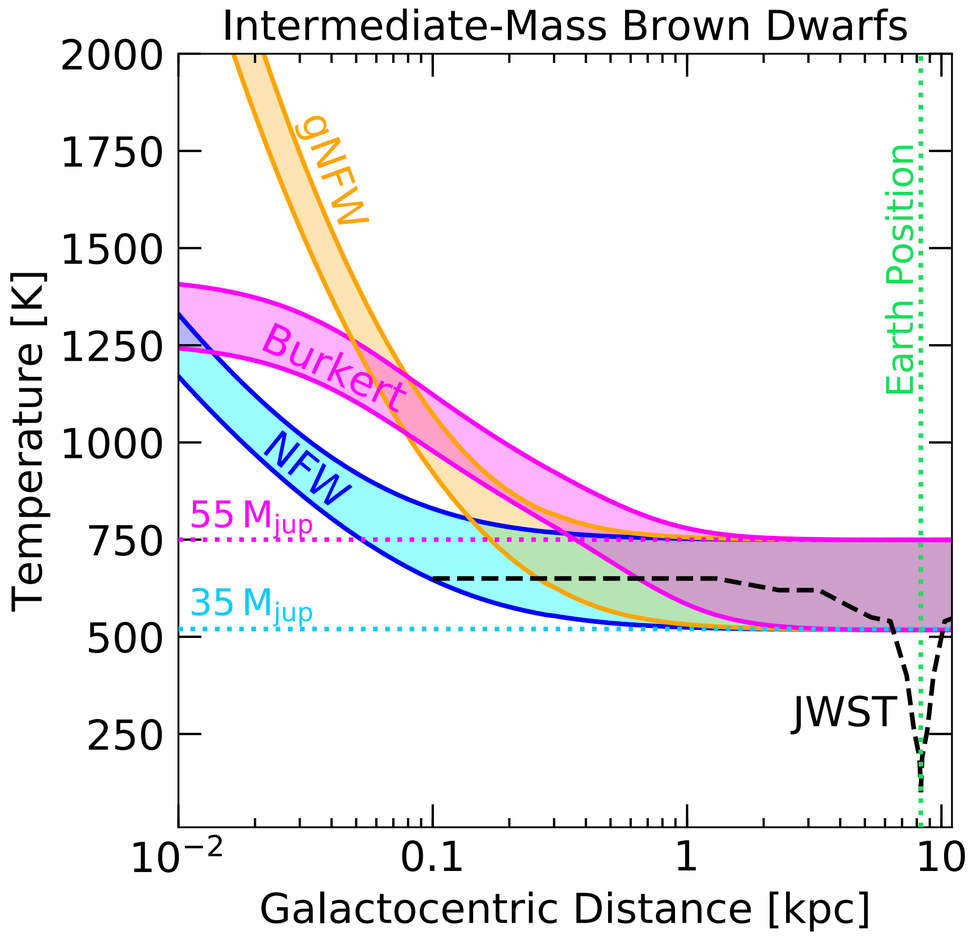
Work in progress: M. Benito (NICPB), R. K. Leane (Stanford), **J. Smirnov**

A Position Dependent Signal



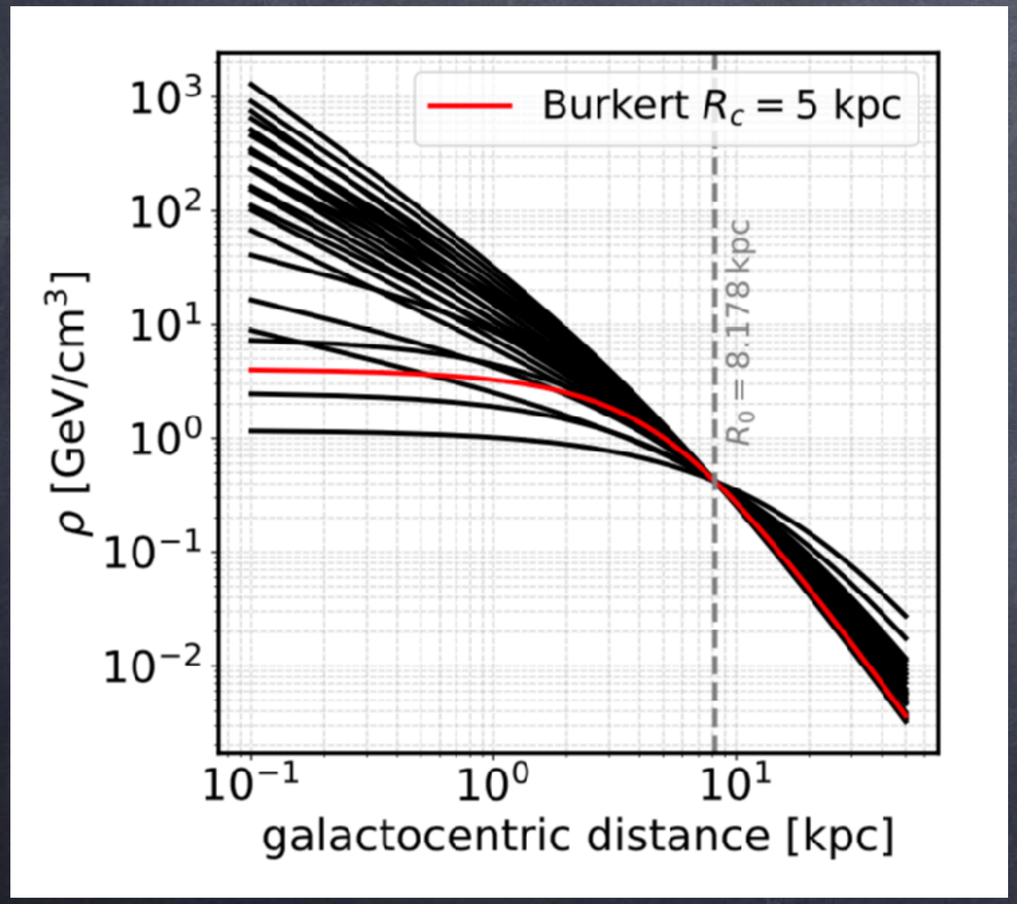
arXiv: 2010.00015; R. K. Leane (Stanford), **J. Smirnov**

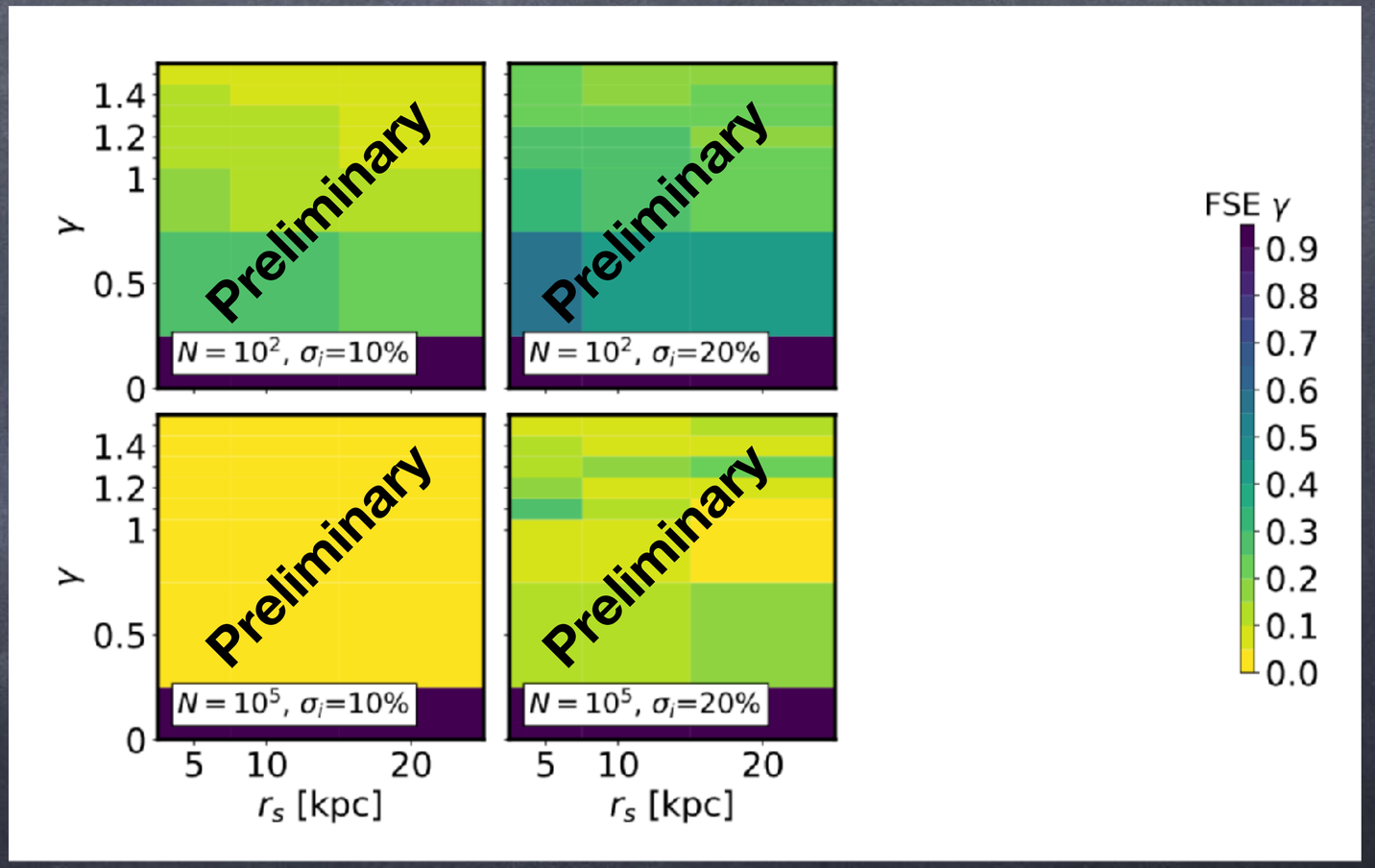
DM Profile Dependence



arXiv: 2010.00015; R. K. Leane (Stanford), **J. Smirnov**

DM Profile Reconstruction

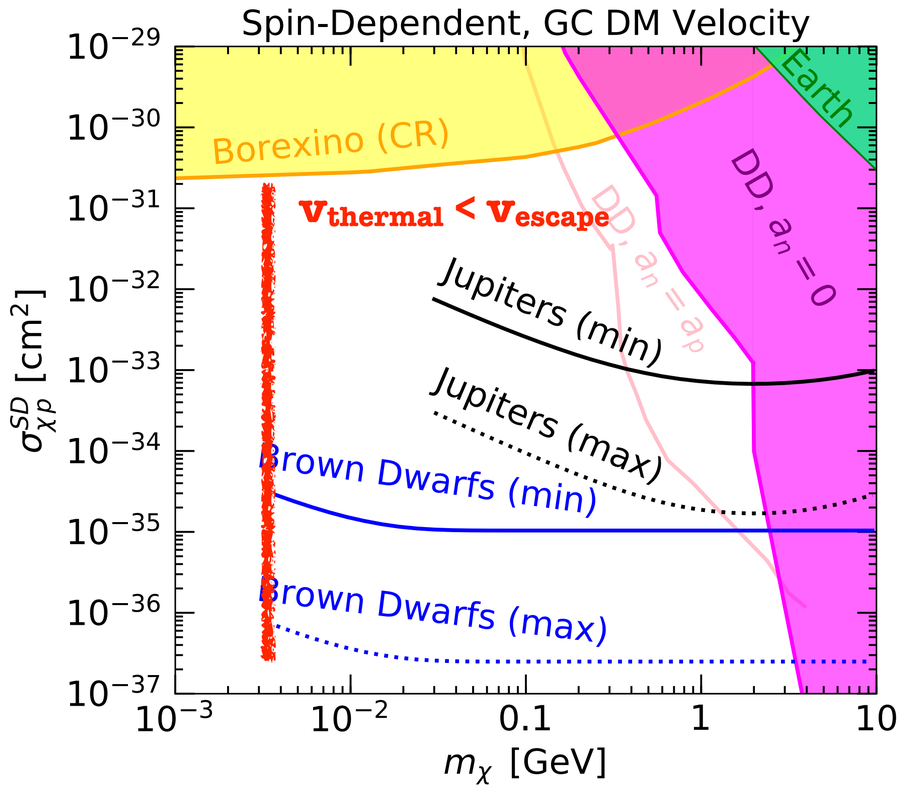




Work in progress: M. Benito (NICPB), R. K. Leane (Stanford), **J. Smirnov**

Dark Matter Models

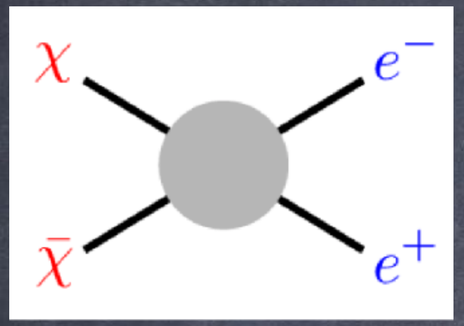
DM-Proton Scattering



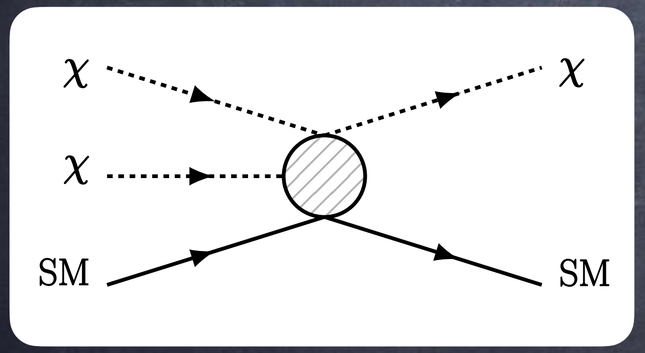
New Line of Research for Light Dark Matter!

arXiv: 2010.00015; R. K. Leane, **J. Smirnov**

Enough Time to Annihilate

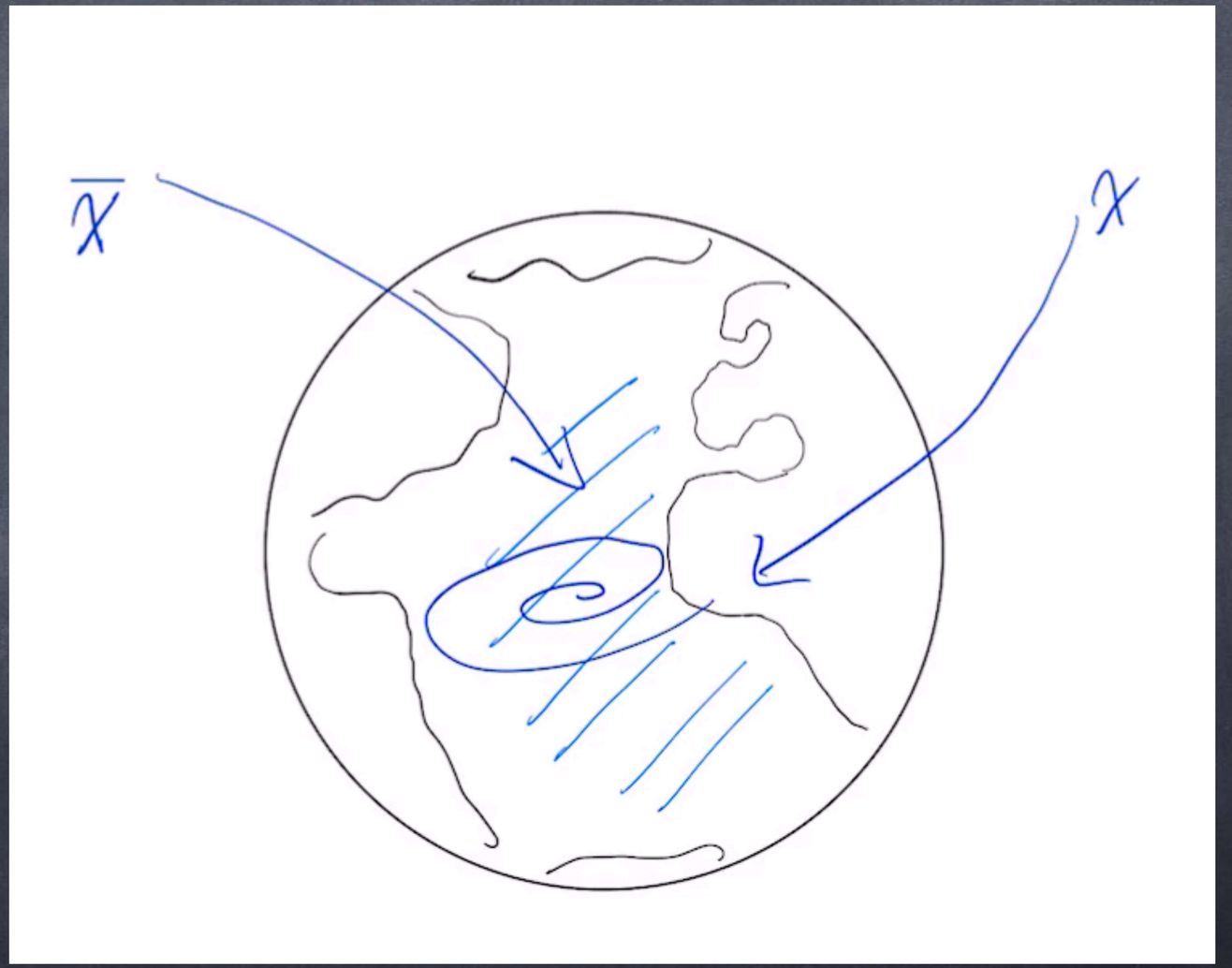


$$\geq \frac{V_{\rm eff}^{2\to 2}}{C_{\rm cap}\tau^2}$$

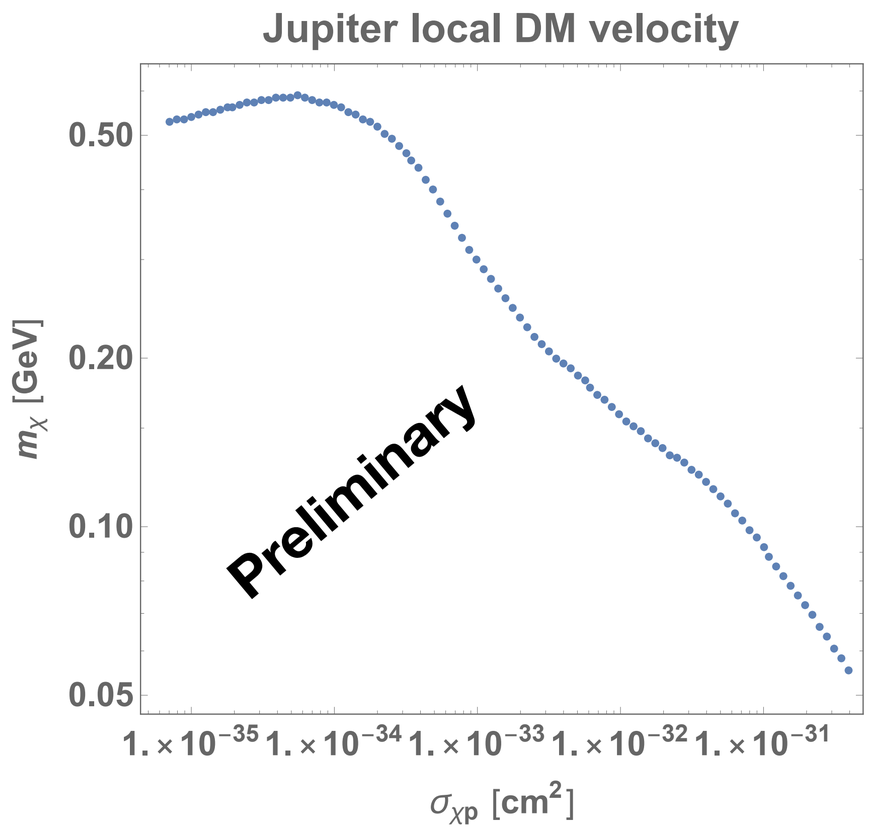


$$\geq \frac{V_{\rm eff}^{2\to 2}}{n_{\rm SM} C_{\rm cap}\tau^2}$$

Co-SIMP process
Phys.Rev.Lett. 125 (2020) 13; J. Smirnov, J. Beacom

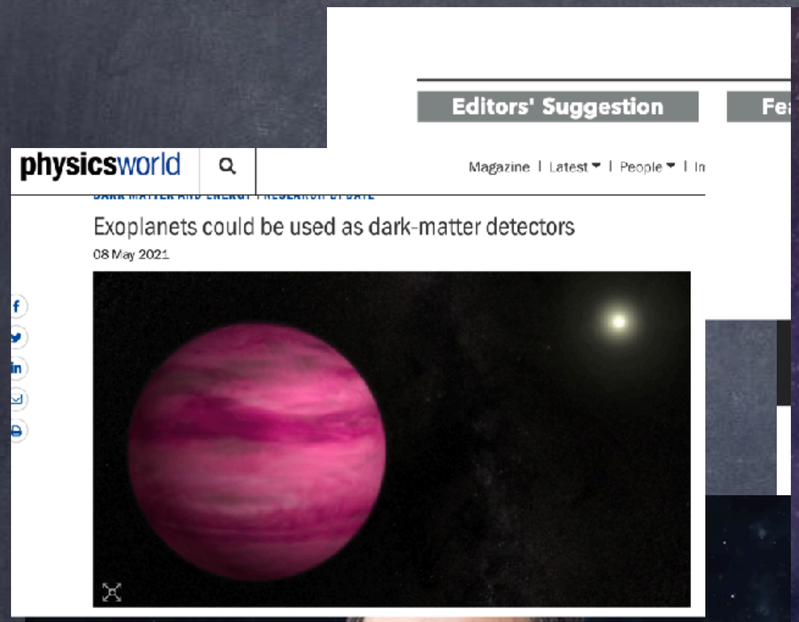


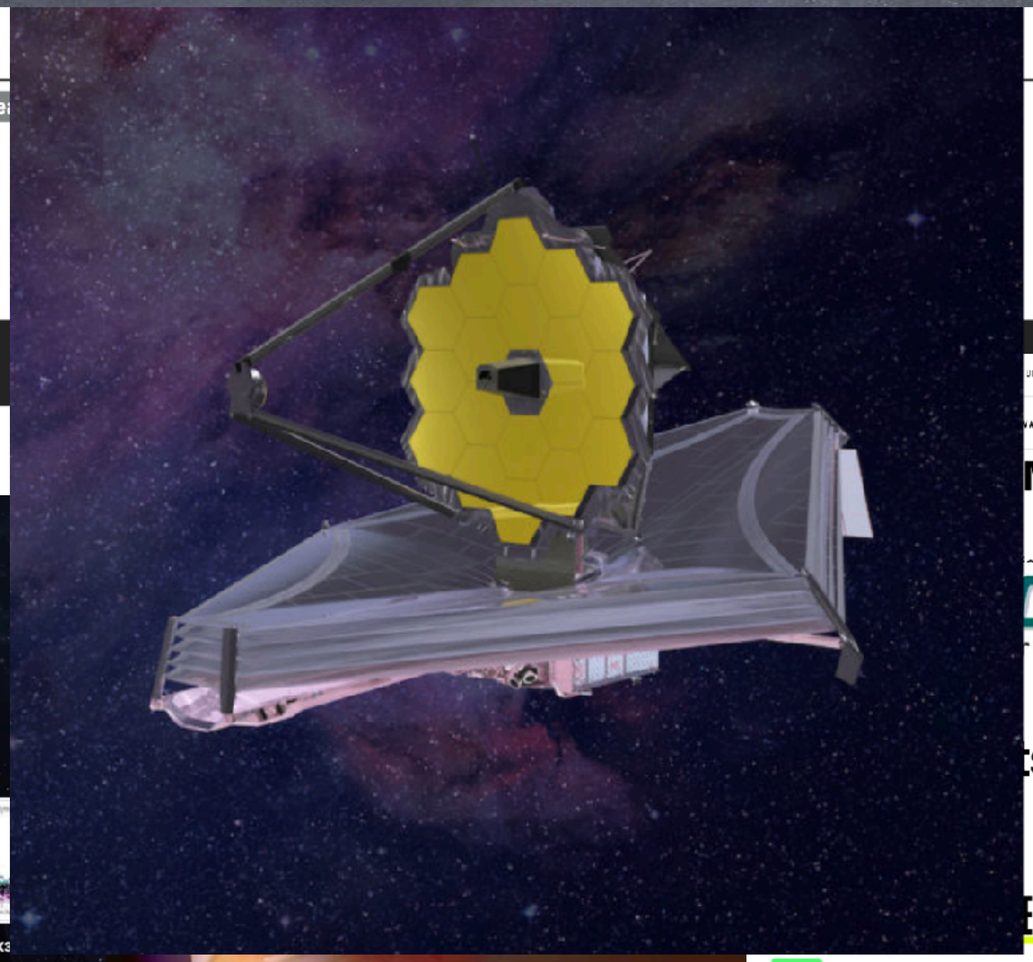
Example Evaporation for 2->2 Annihilation

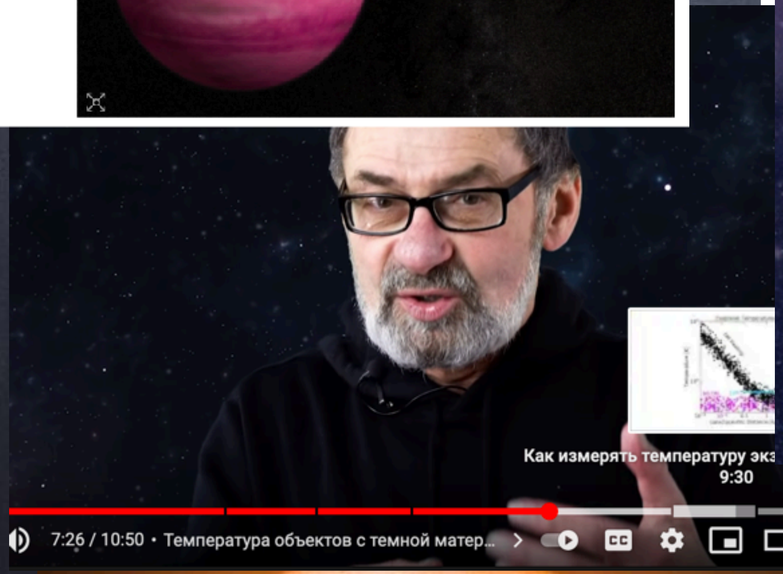


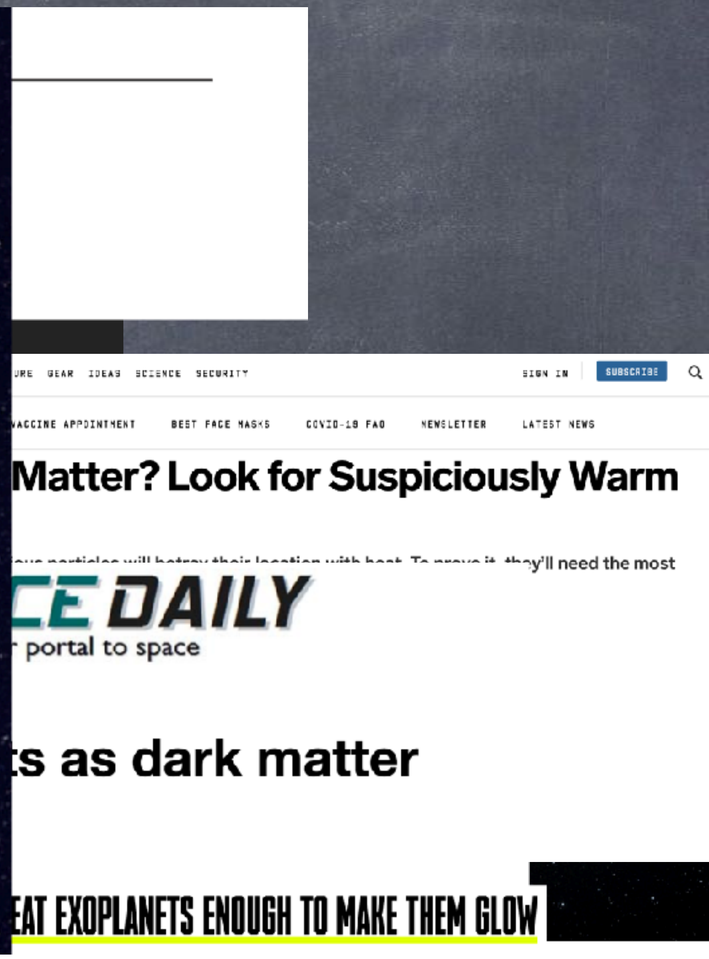
Work in progress R. K. Leane, **J. Smirnov**

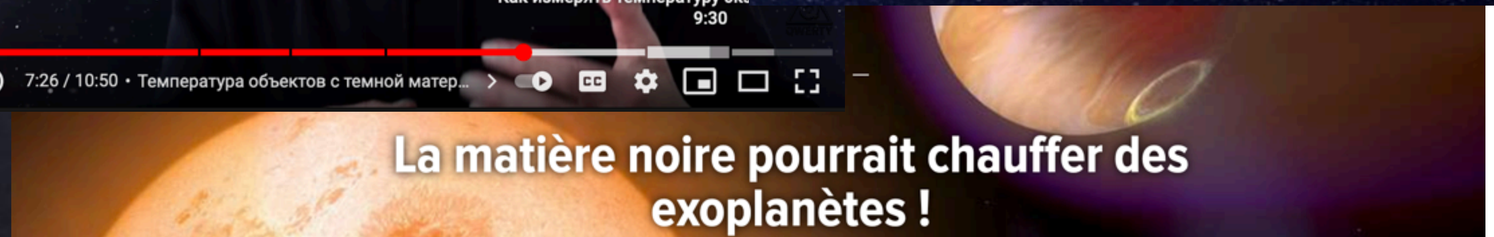
New Worlds Ahead

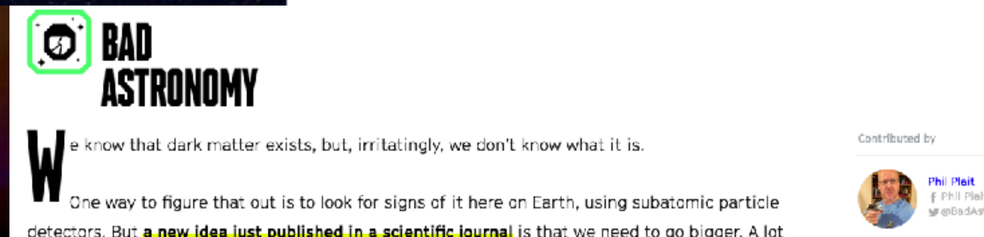








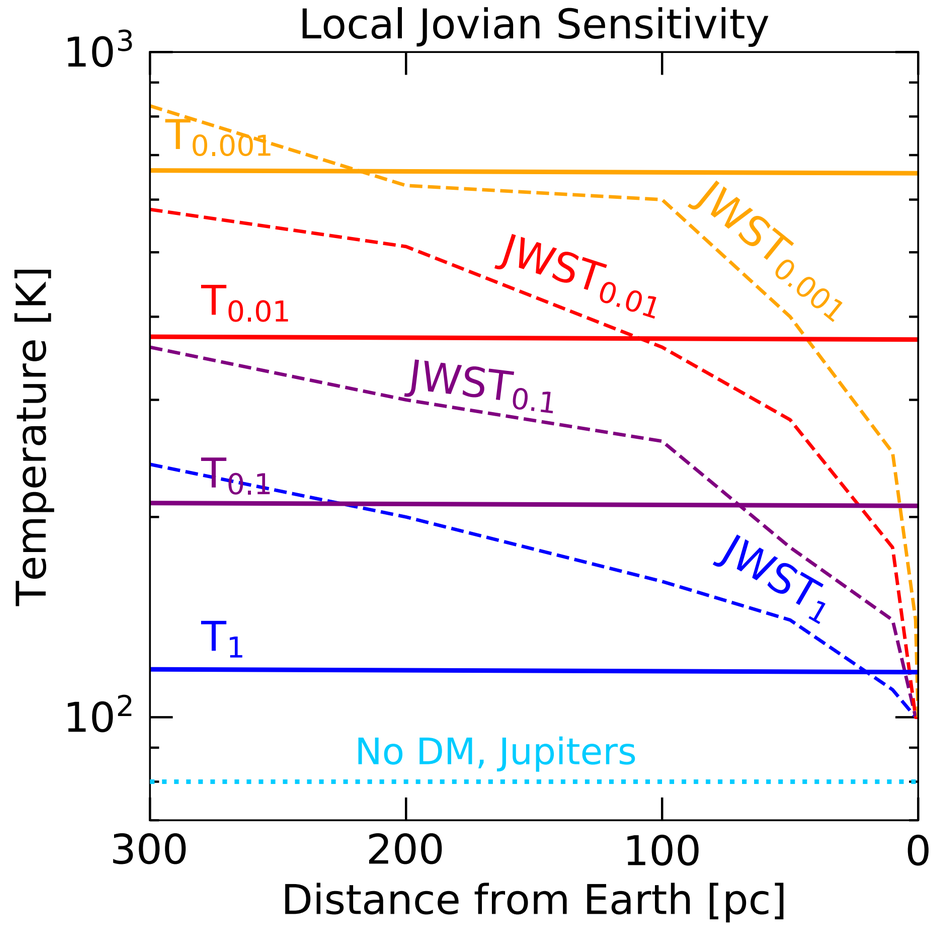




Thanks!

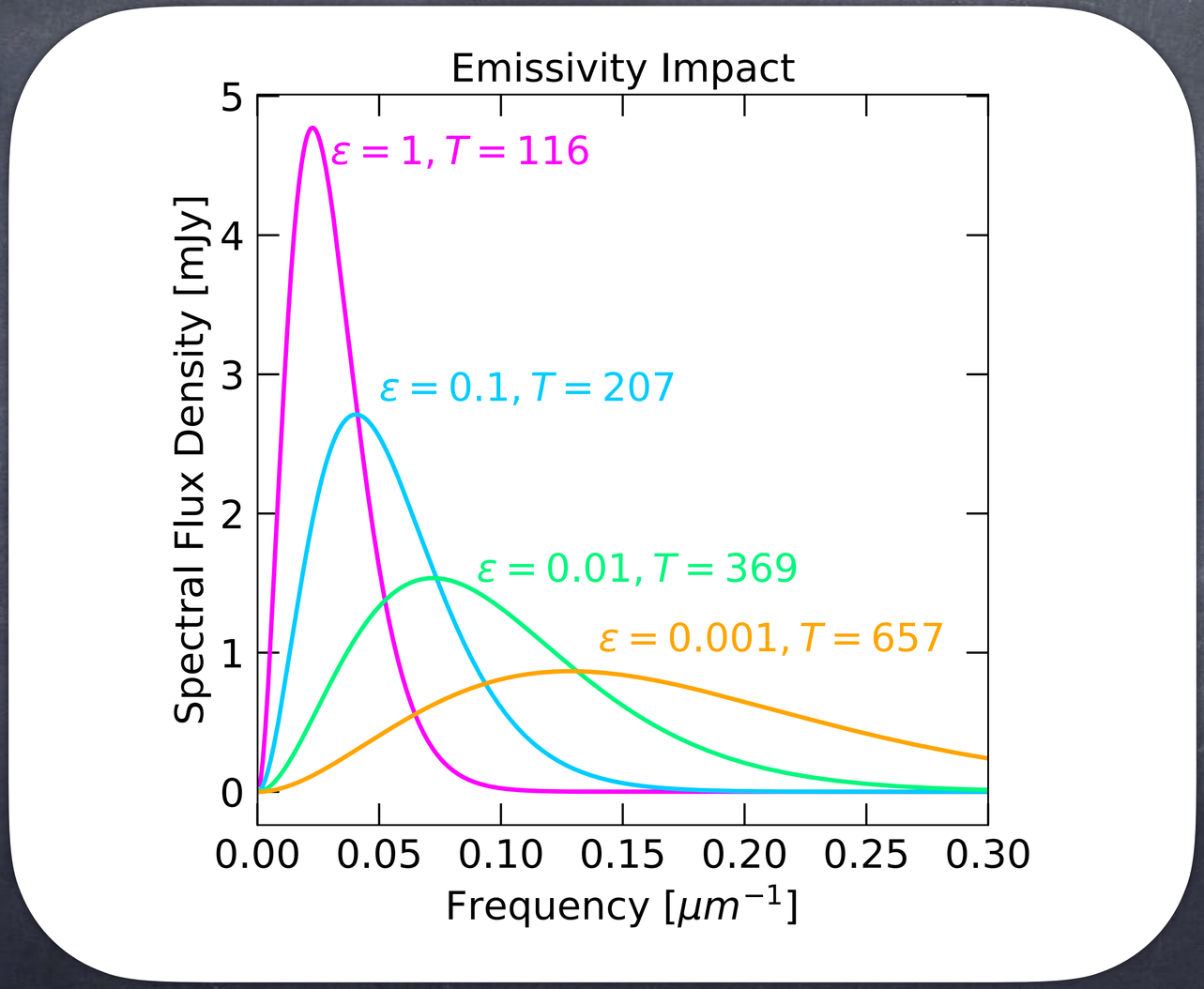
Backup

Local Search



arXiv: 2010.00015; R. K. Leane (Stanford), **J. Smirnov**

Atmospheric Emissivity



arXiv: 2010.00015; R. K. Leane (Stanford), **J. Smirnov**