

# Dark Matter Direct Search Rates in Simulations of the Milky Way and the Sagittarius Stream

**Chris Purcell**



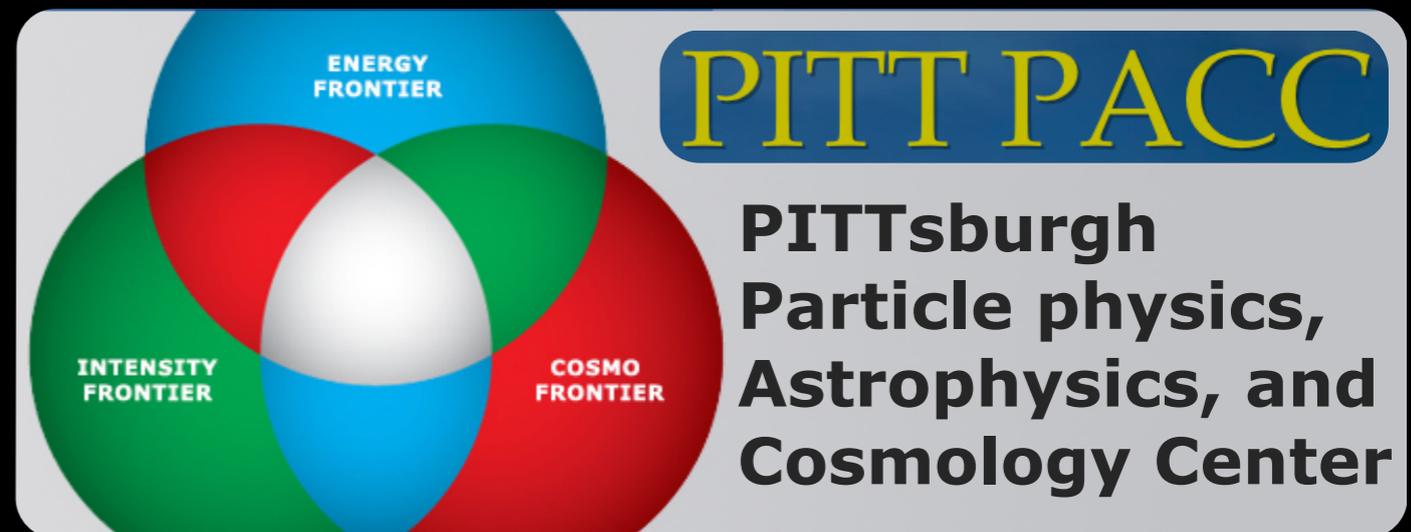
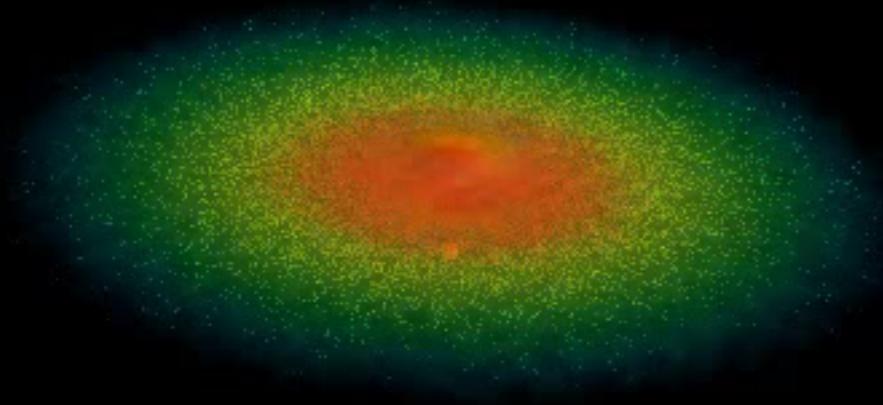
University of Pittsburgh

with

Andrew Zentner  
and Mei-Yu Wang

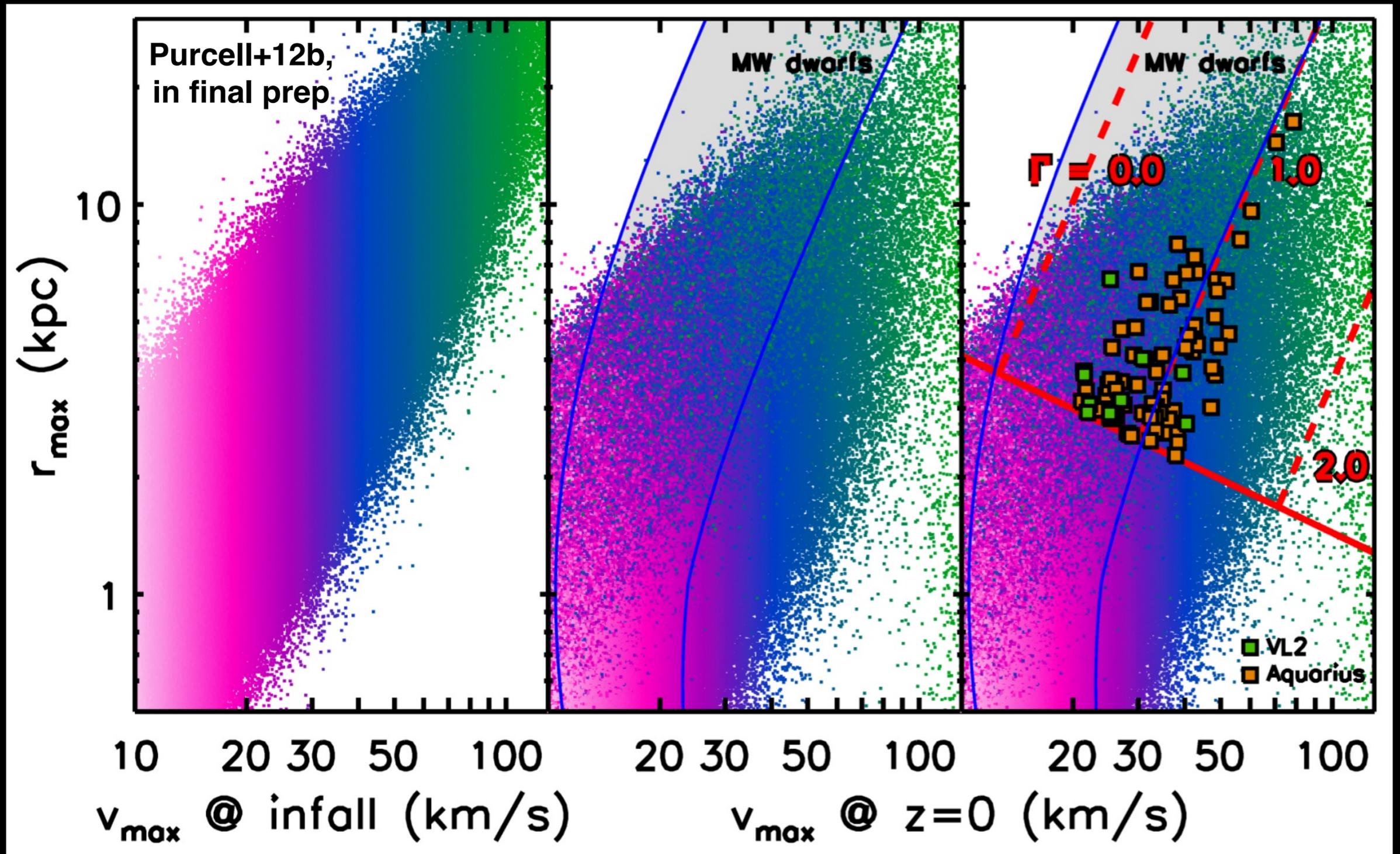
**Purcell et al. 2012a**

ArXiv: astro-ph/1203.6617





# Bailing out the Milky Way

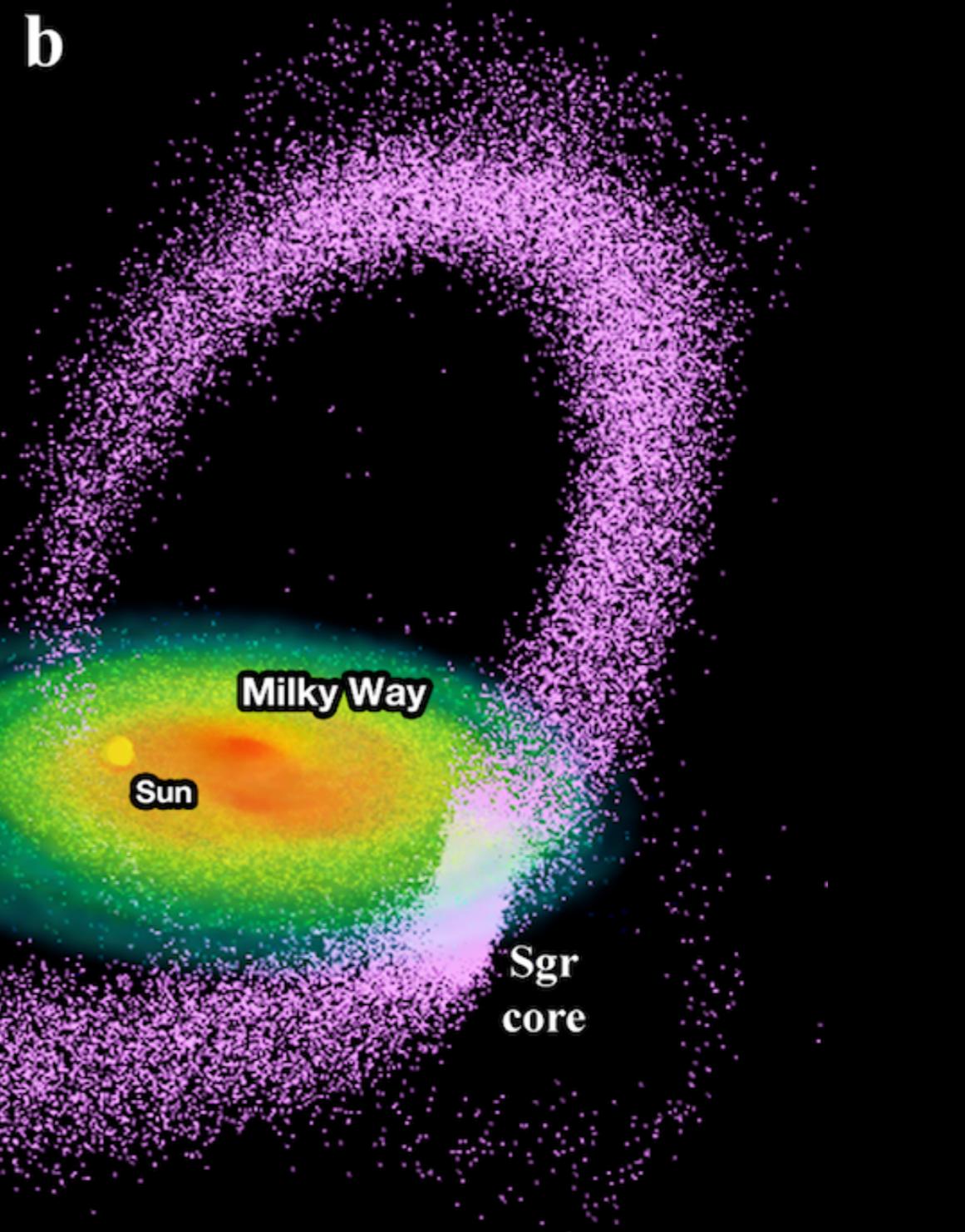
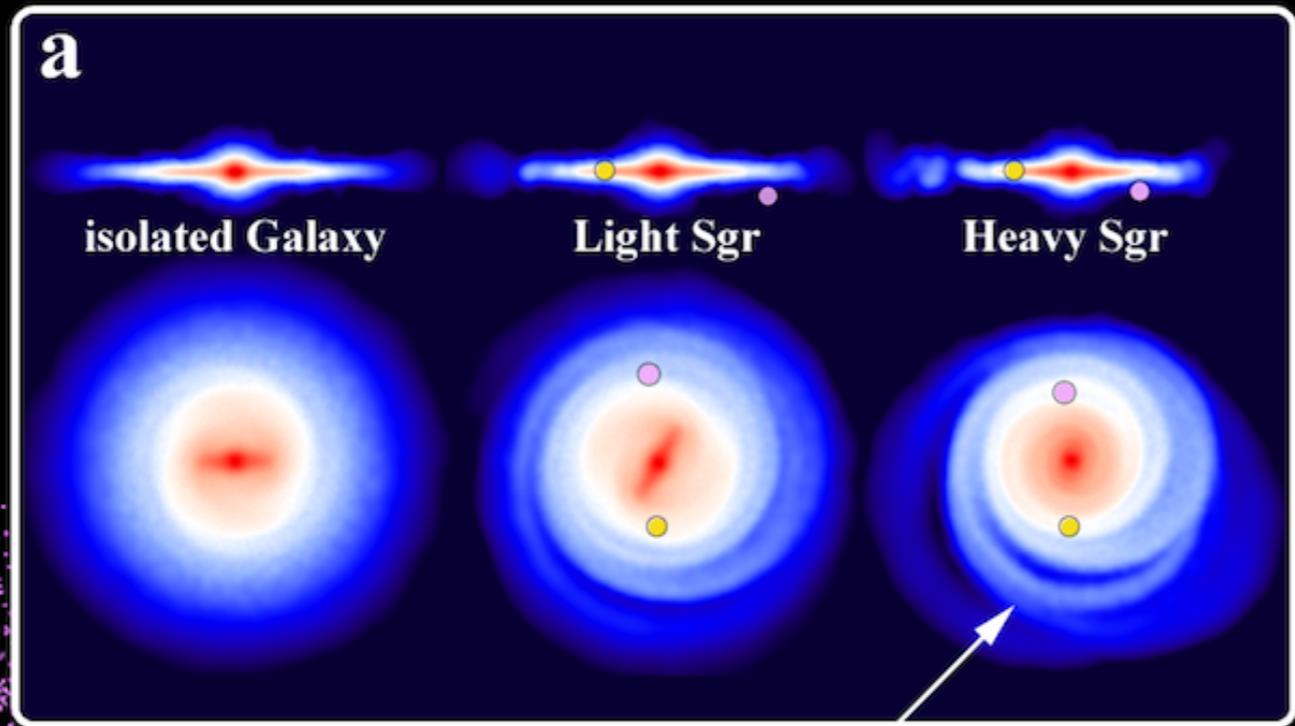


...there *is* no **too big to fail** problem!

# Sagittarius Debris at Earth

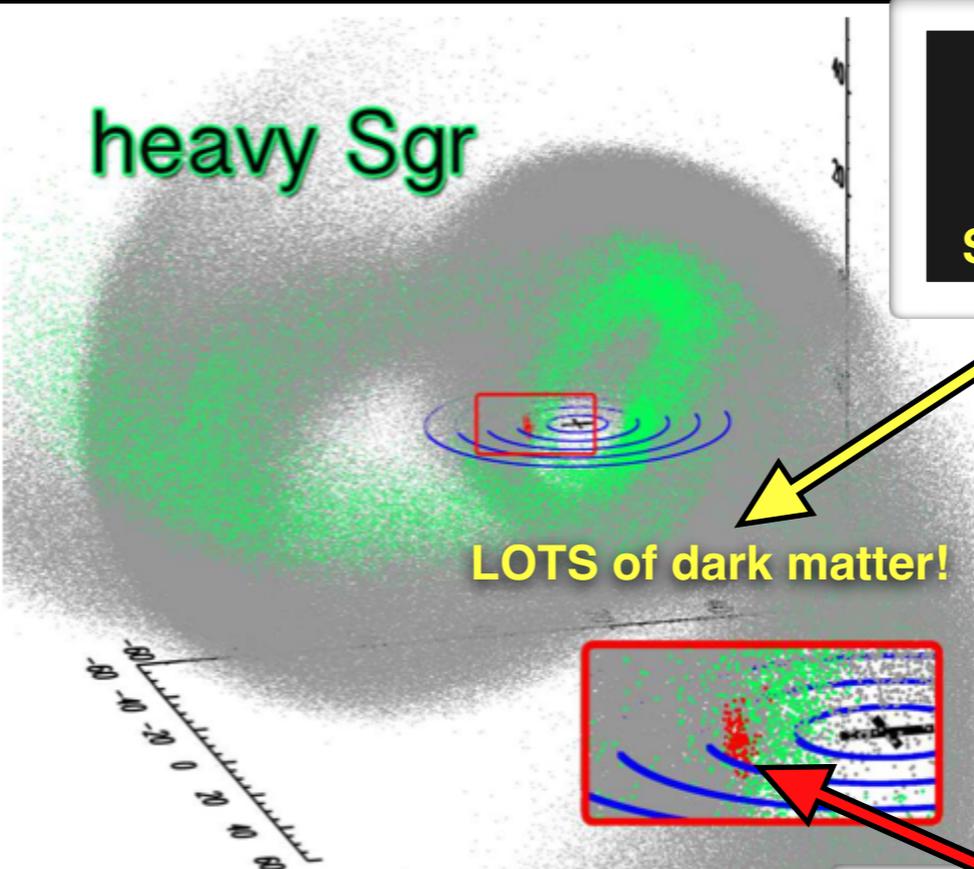
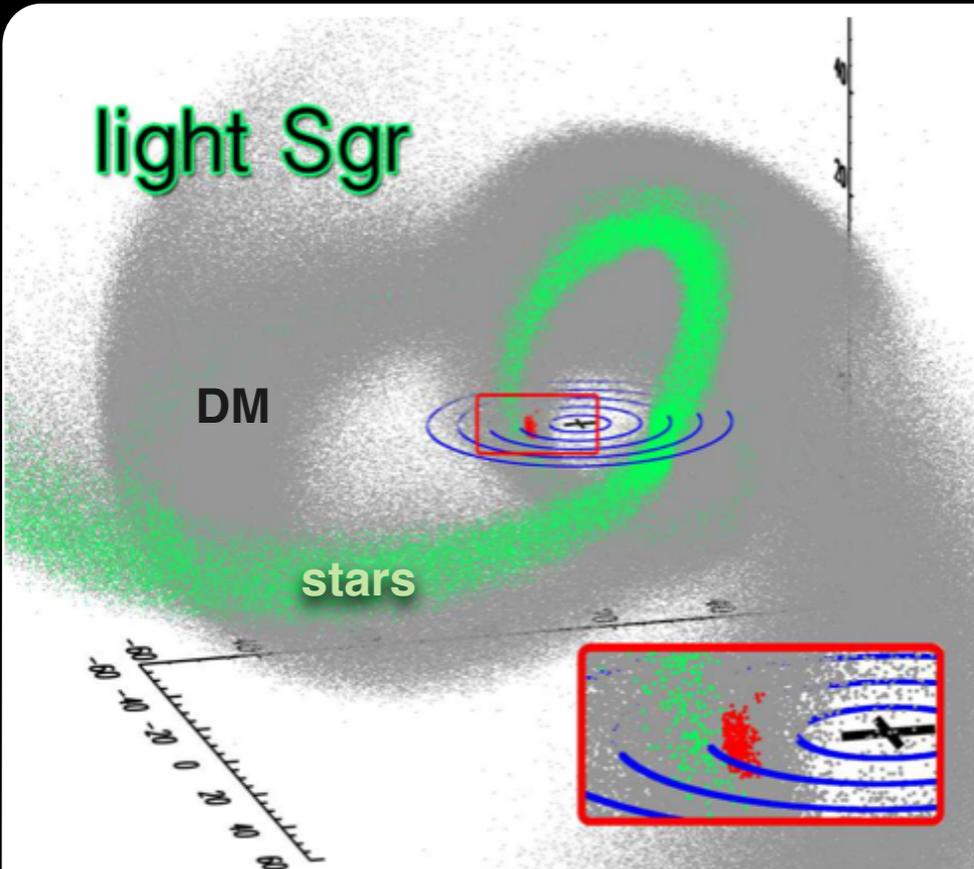
this work based on:  
Purcell et al. 2011 ( **nature** 477, 7364, 301 )

The **Sagittarius Impact** as an Architect of **Spirality** and **Outer Rings** in the **Milky Way**



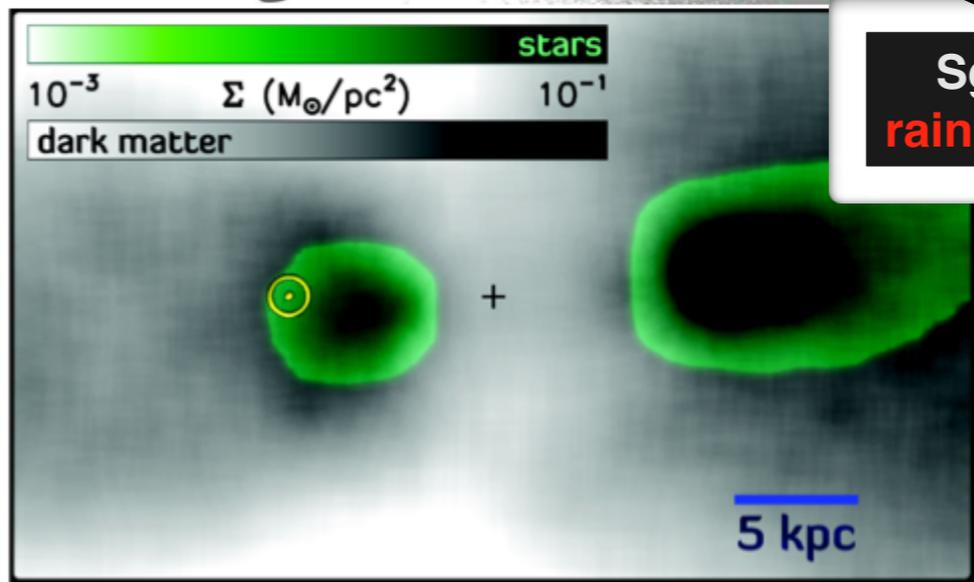
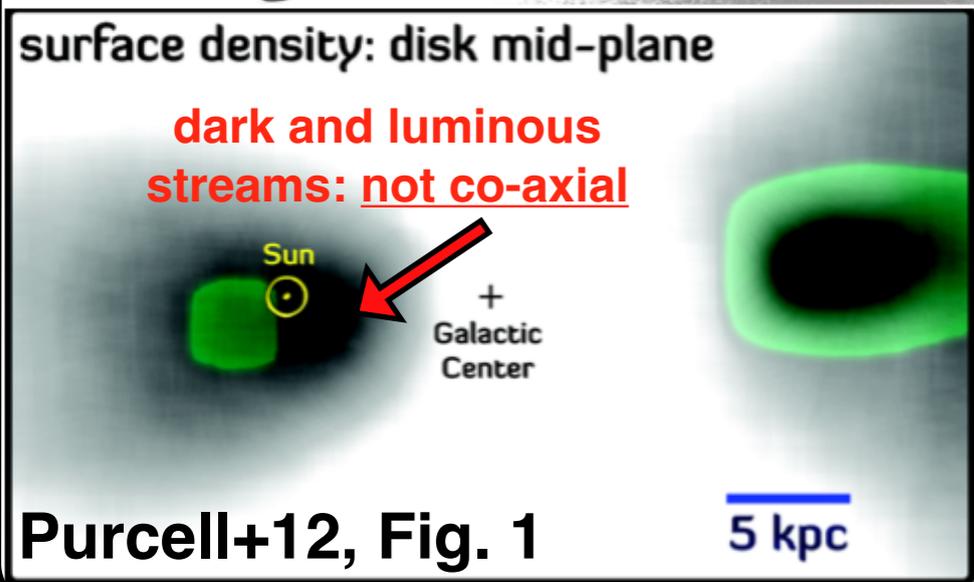
stream of tidal debris  
from Light Sgr dwarf  
satellite galaxy

# Sagittarius Debris at Earth



from cosmological context  
and kinematic  
reconstructions:  
**Sgr progenitor was massive**

**light Sgr  $\approx 10^{10.5} M_{\odot}$**   
**heavy Sgr  $\approx 10^{11} M_{\odot}$**

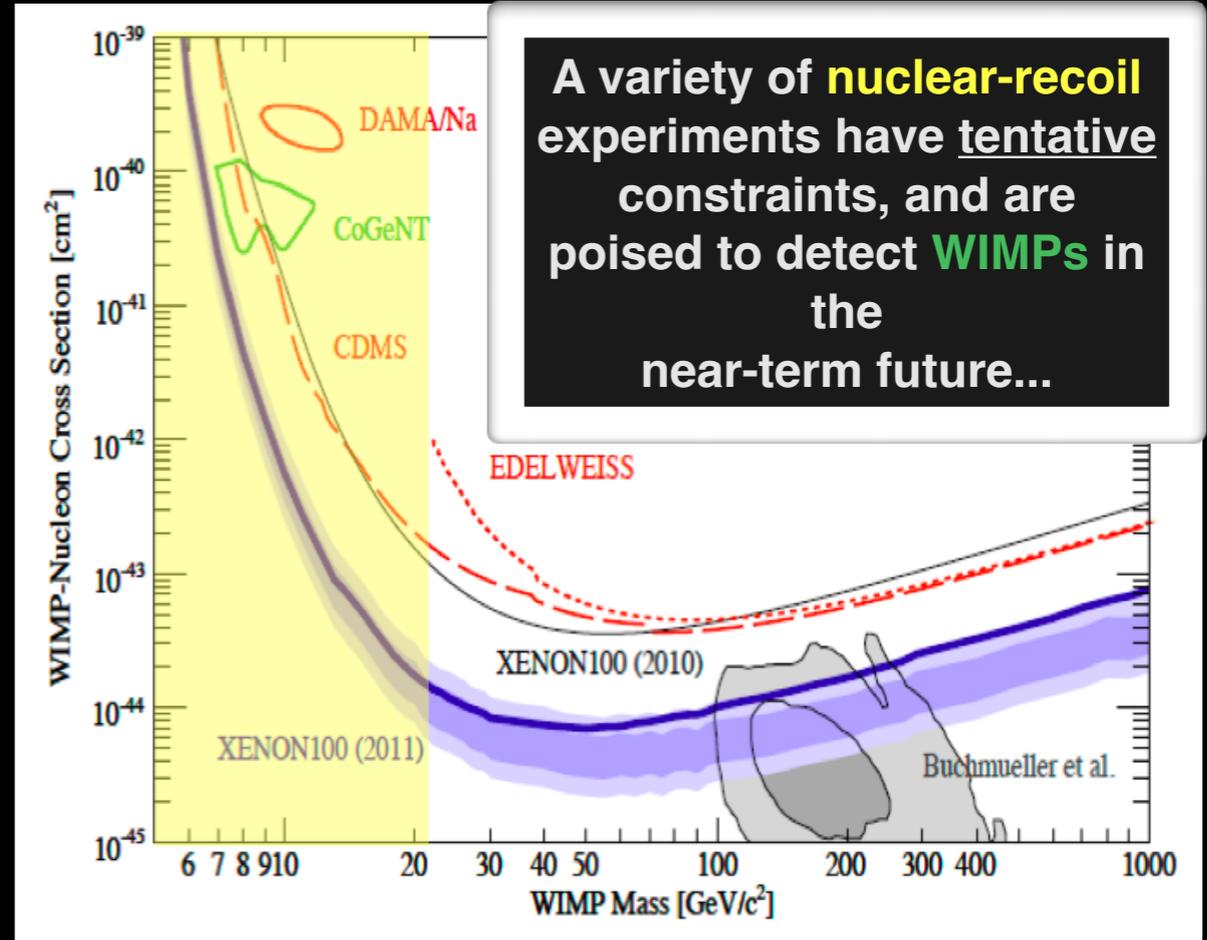
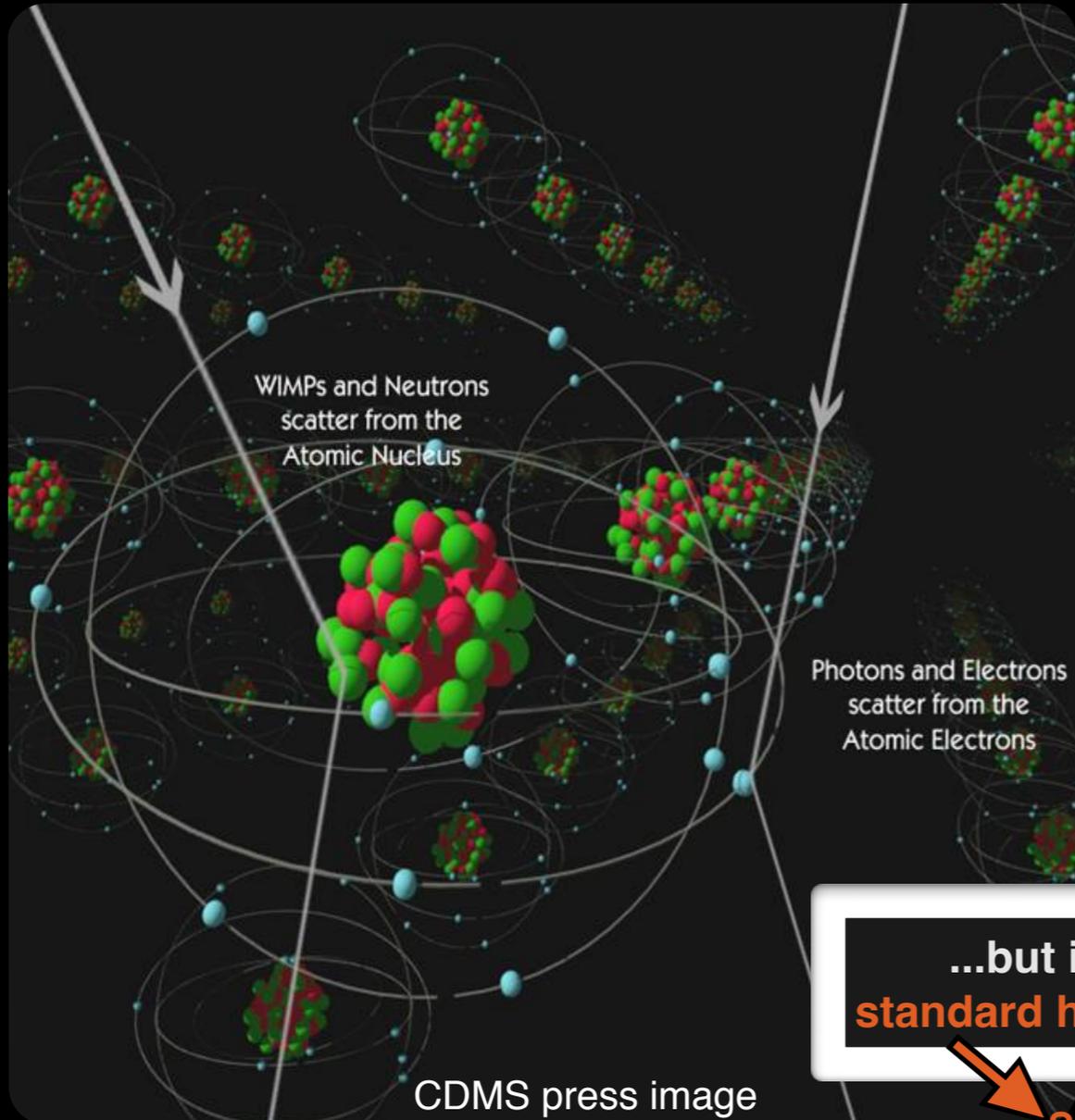


Sgr dark matter tidal arm is  
**raining directly onto the Earth...**

...even though the  
**stellar stream** is not!

e.g. Seabroke et al. '08  
Correnti et al. '10  
Law & Majewski '10

...no evidence for **vertically-coherent kinematic sub-populations** within  $\sim 100$  pc of Sun:  
e.g. Helmi et al. 2006; Re Fiorentin et al. 2011

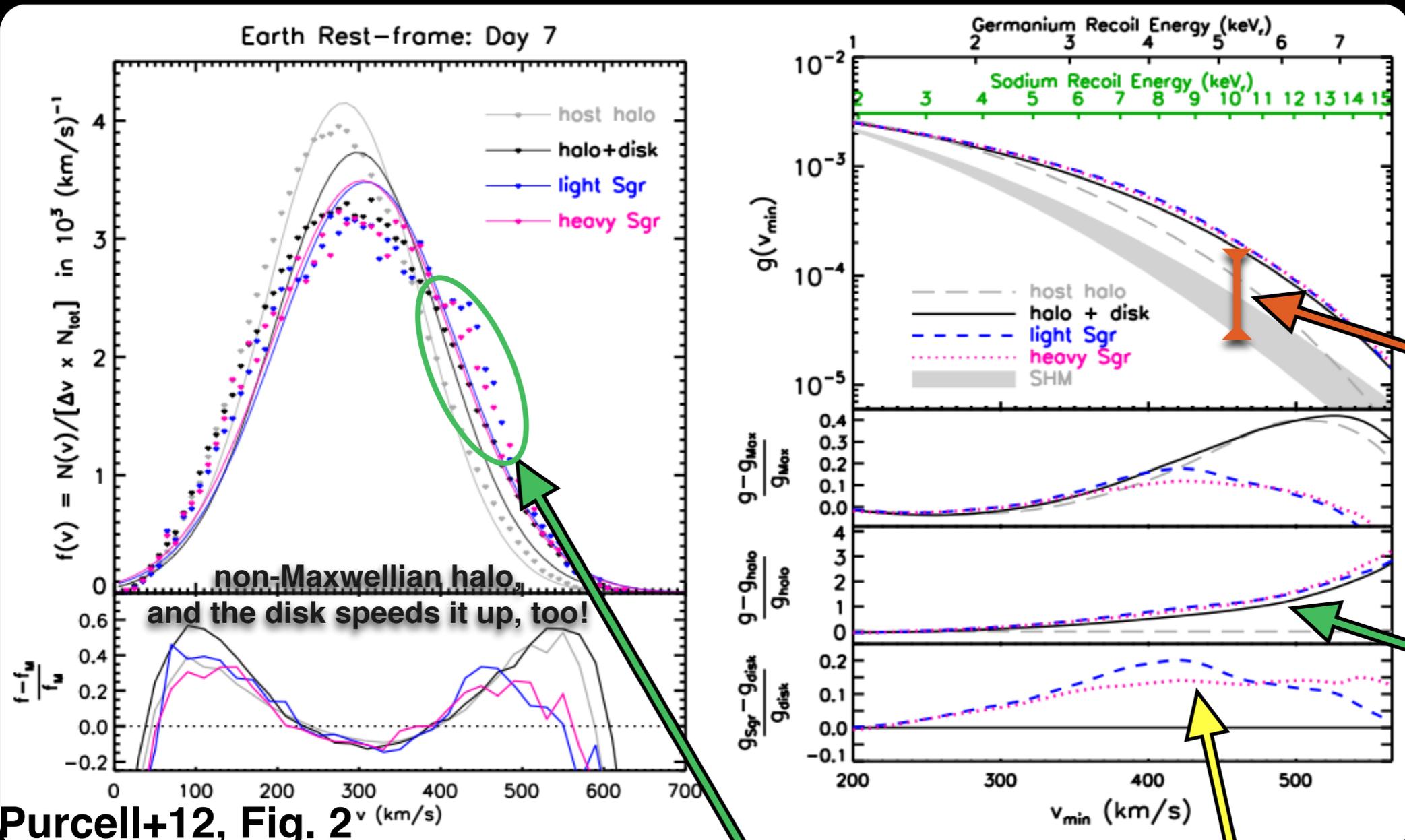


A variety of **nuclear-recoil** experiments have tentative constraints, and are poised to detect **WIMPs** in the near-term future...

...but interpretations of the event rates typically assume a **standard halo model** of the **local speed distribution of dark matter!**

SHM: isothermal halo; Maxwellian  $f(v)$

**scattering event rate**  $= \frac{dR}{dE} \sim g(v) = \int_{v_{\min}}^{\infty} f(v) / v$

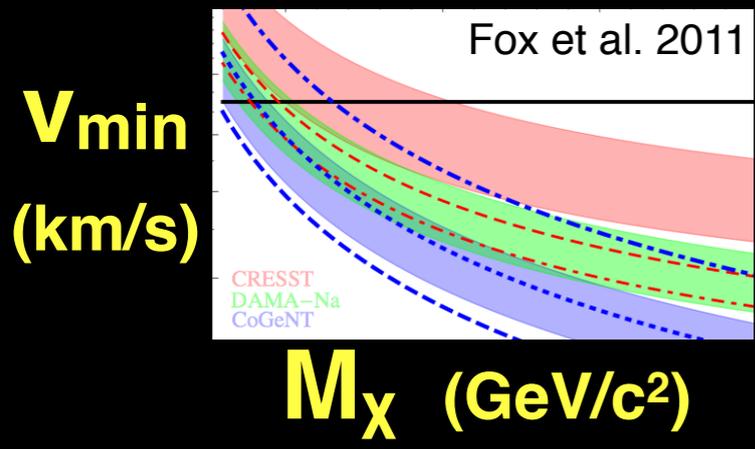


$$\frac{dR}{dE} \sim g(v)$$

standard halo model underestimates event-rates by a factor of >2-5!

stellar disk also boosts rates by a factor of 2 or more!

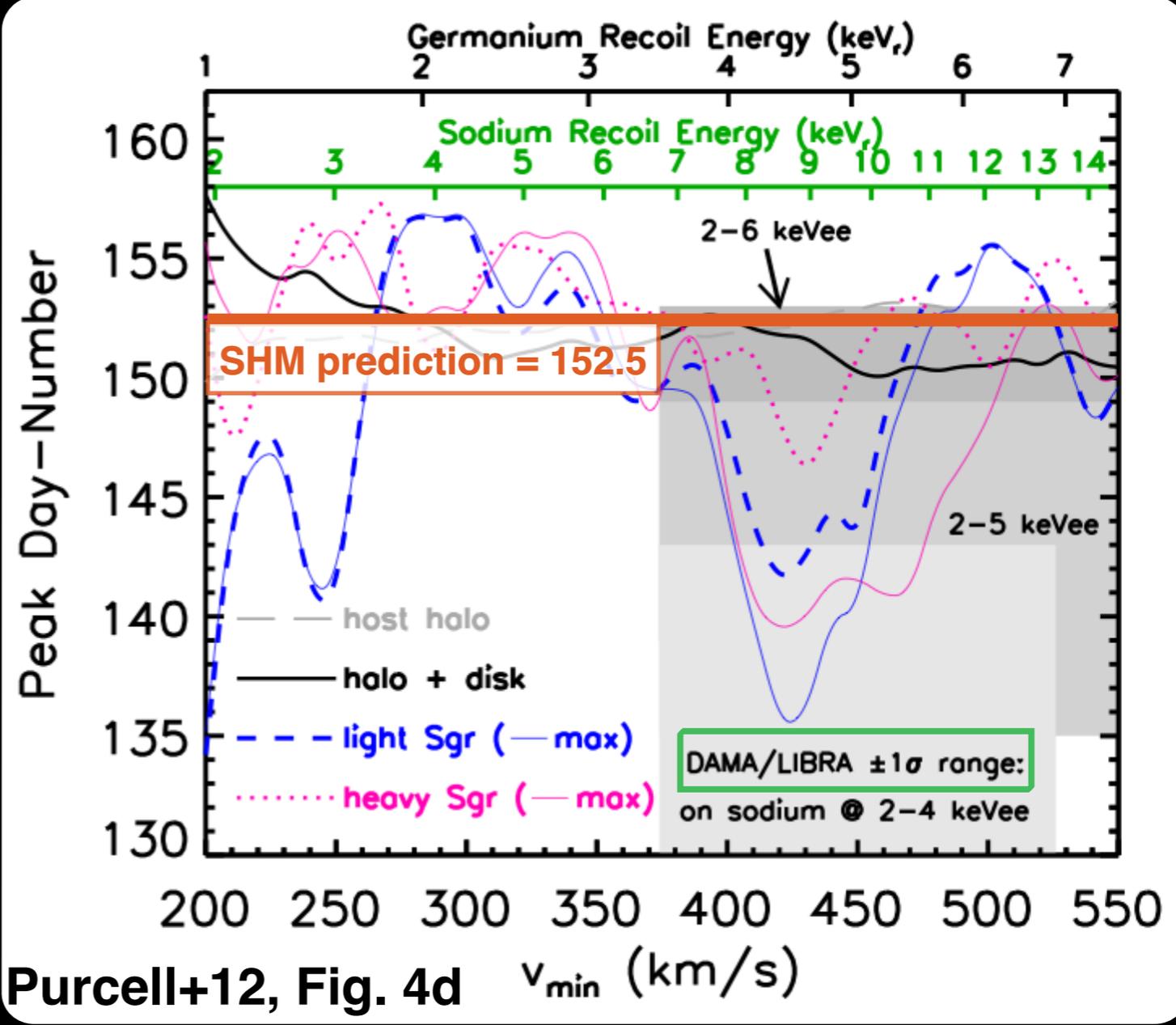
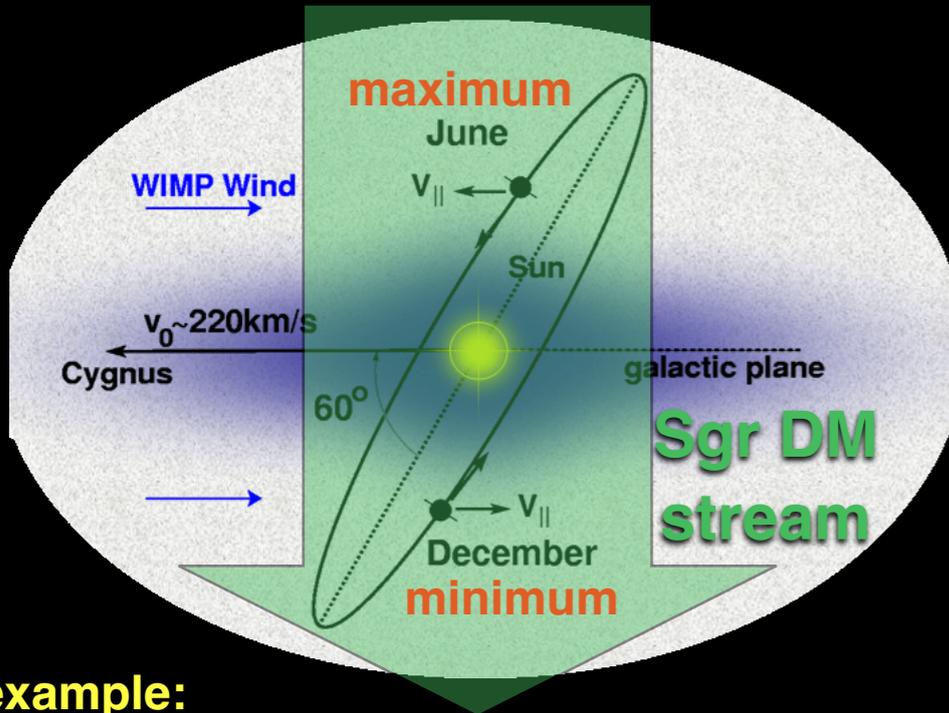
even small non-Maxwellian features can boost the event rate when integrating over the high-end of the speed distribution, so Sagittarius debris adds another ~10-20% (for light WIMPs)



Purcell+12, Fig. 2

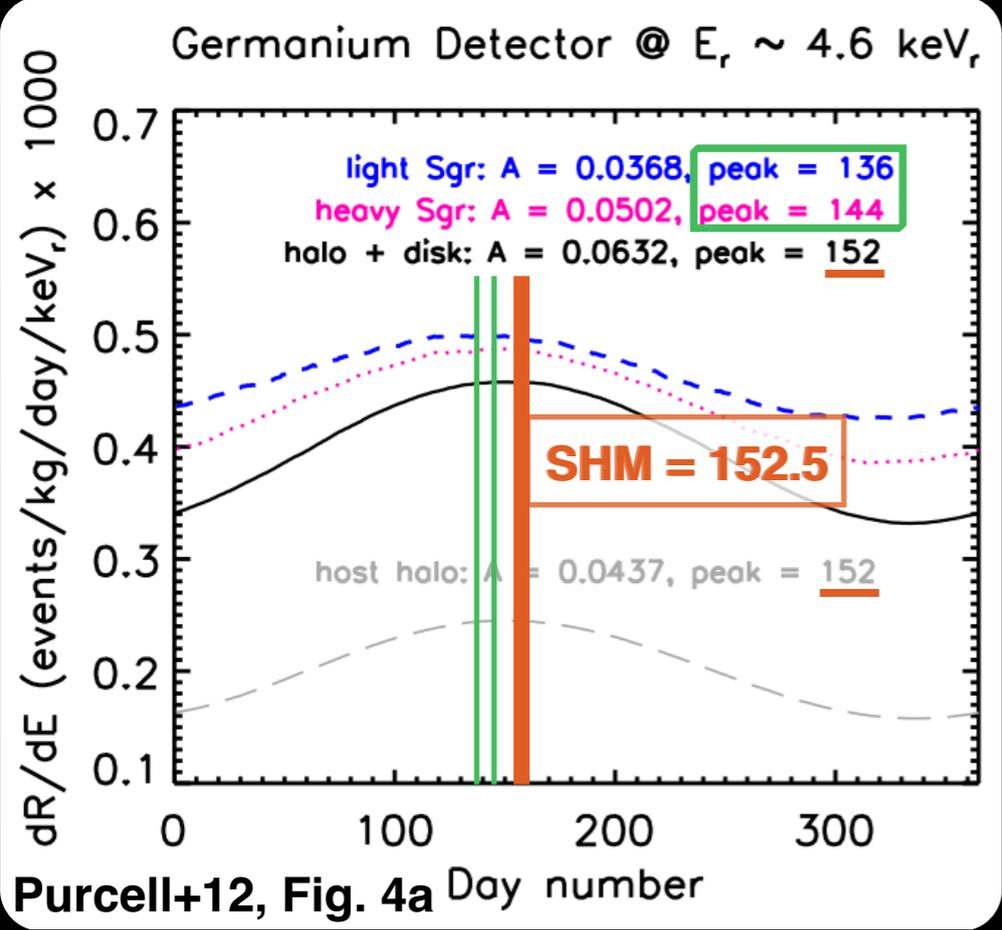


# Annual Modulation: Sgr Signal?



Purcell+12, Fig. 4d

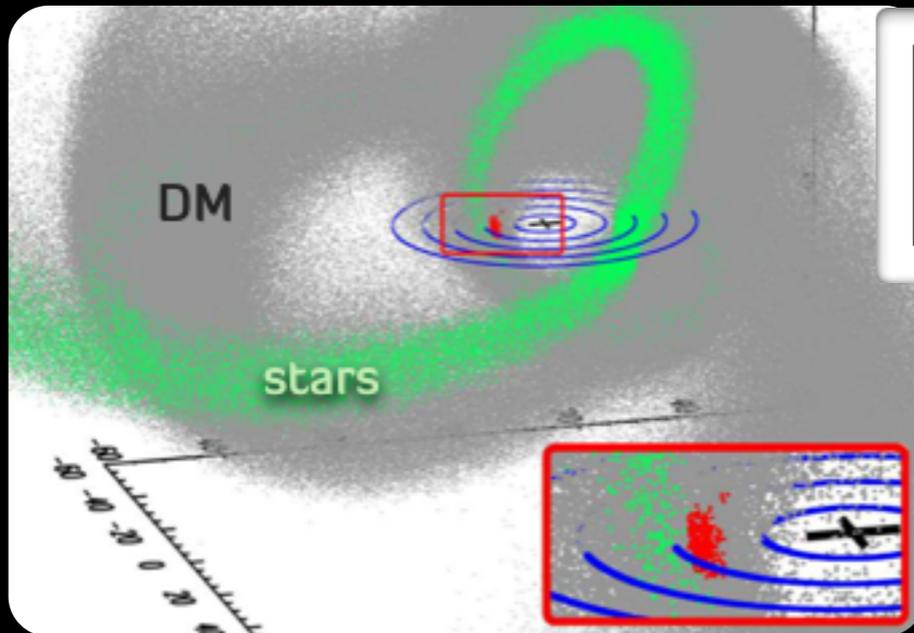
example:



Purcell+12, Fig. 4a

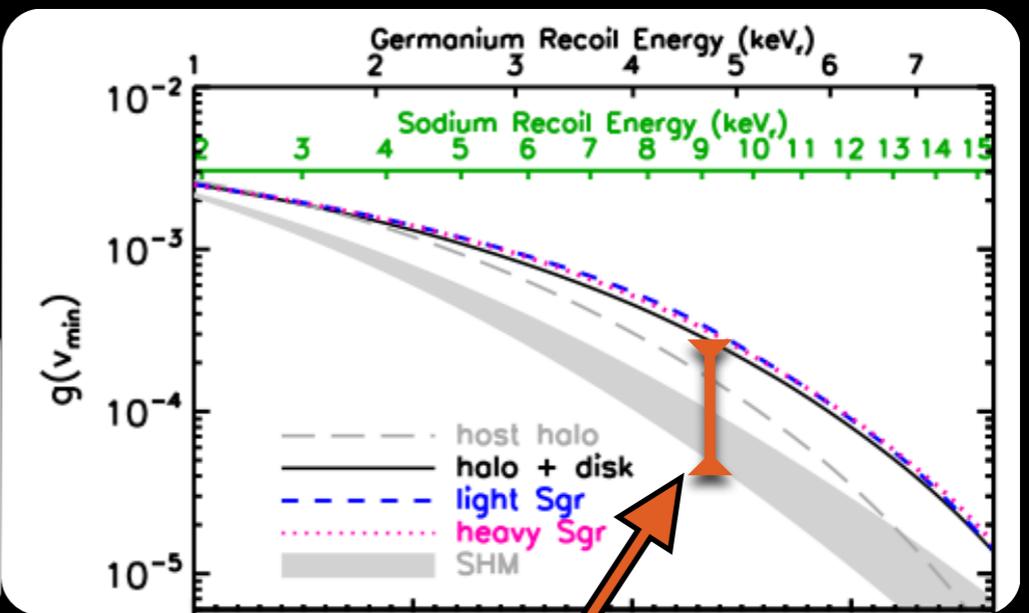
Only **significant debris flows** (and not ancient micro-streams) can drag the peak away from the **SHM-predicted value** by several days...

...is DAMA already "seeing" Sgr dark matter?

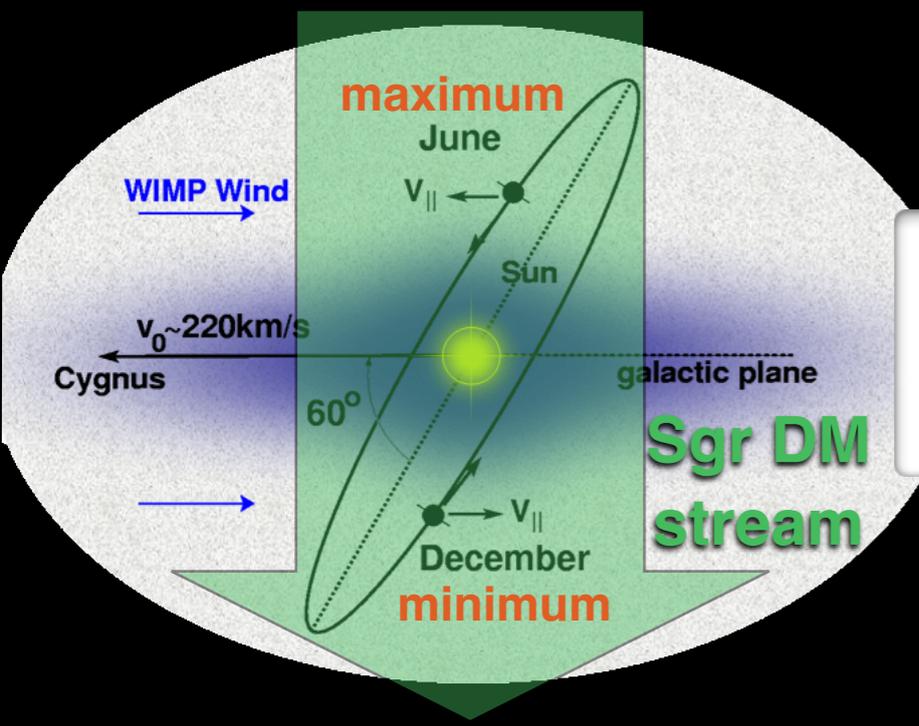


Dark matter from the *disrupting Sagittarius dwarf* is raining onto Earth at the solar neighborhood, and induces a **~10-20% boost** in recoil-event rates

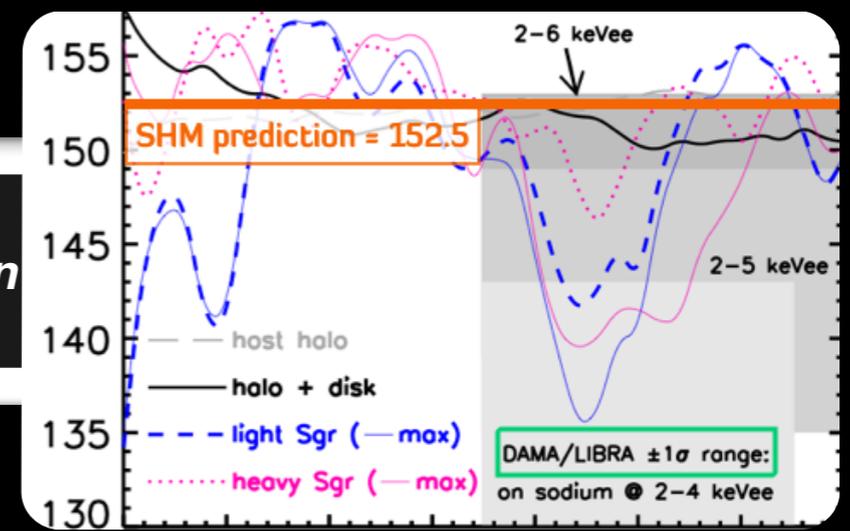
Self-consistent mapping from *N-body halo rates* (e.g. for VL2, Aquarius) to those predicted for same halos with *realistic Galactic disks*: important on **factor of ~2 level**



...and the SHM badly underestimates dR/dE: stop using it!



*Coherently-moving Sgr debris* changes phase of annual modulation signal by **as much as ~10-20 days**



...experiments are poised to test DAMA/LIBRA and could confirm Sgr dark matter on Earth!