

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

Chris Purcell



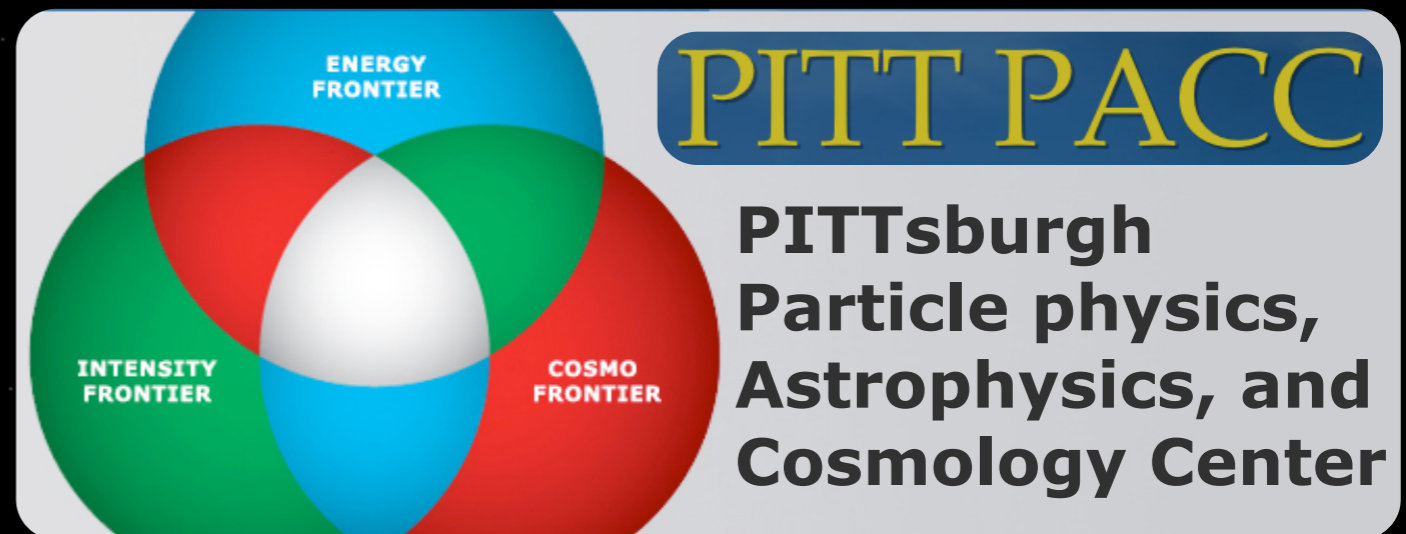
University of Pittsburgh

with

Andrew Zentner
and Mei-Yu Wang

Purcell et al. 2012

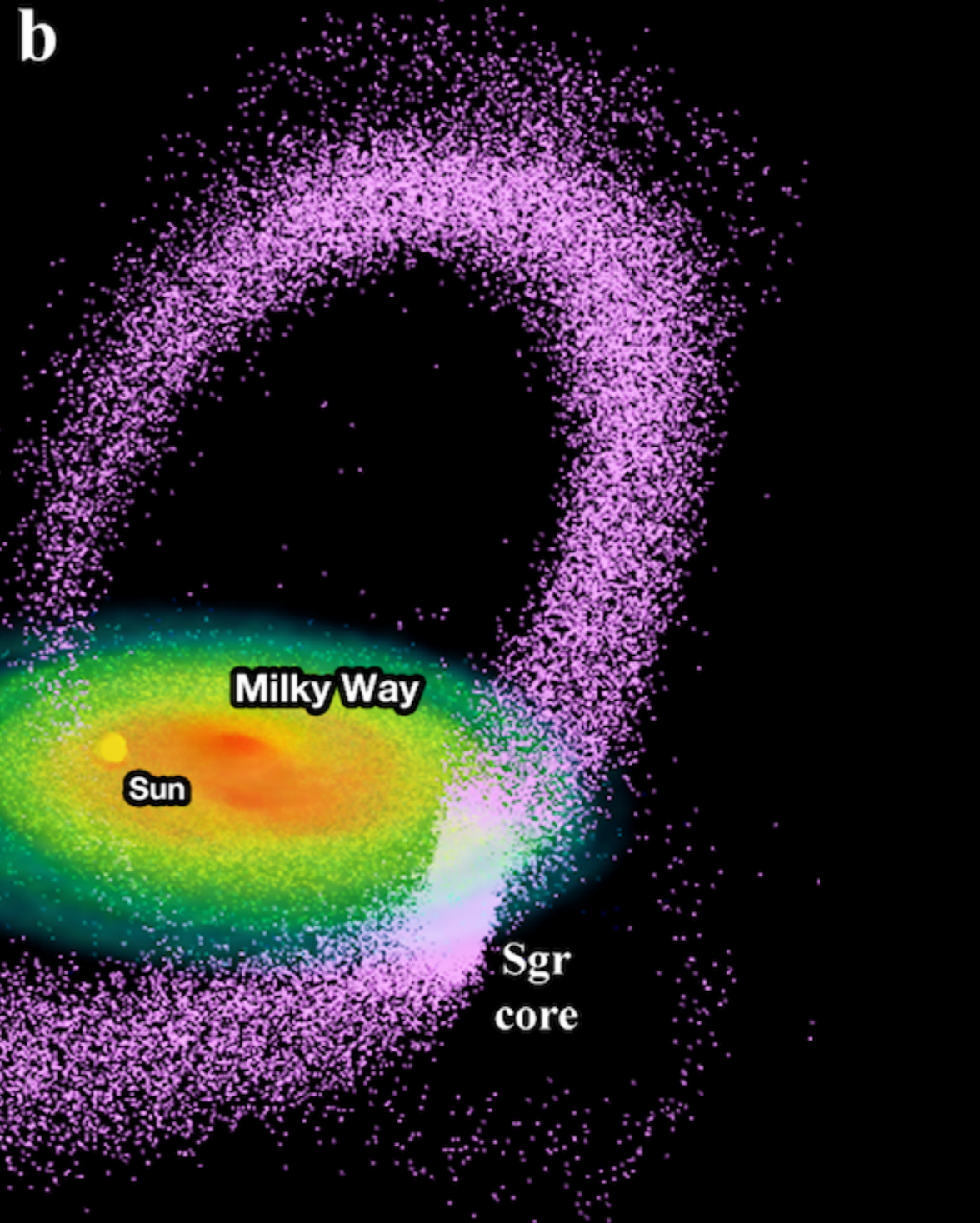
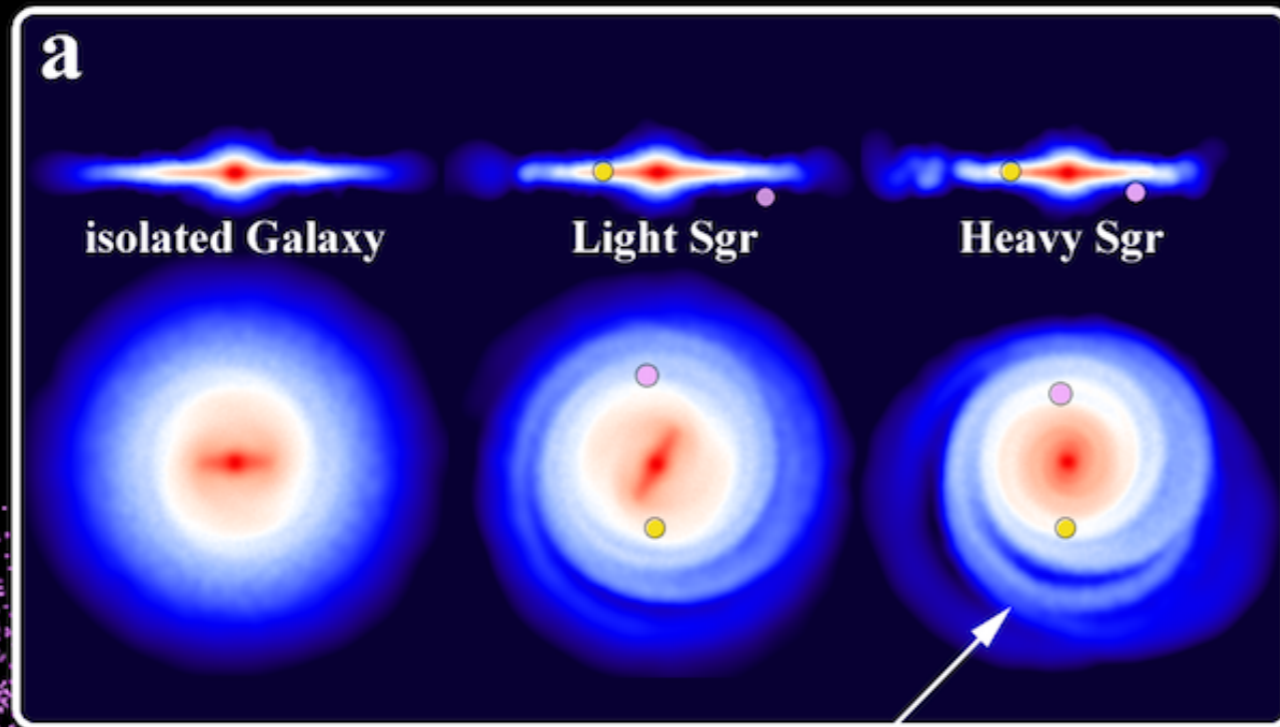
ArXiv: astro-ph/1203.6617



Sagittarius Debris at Earth

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

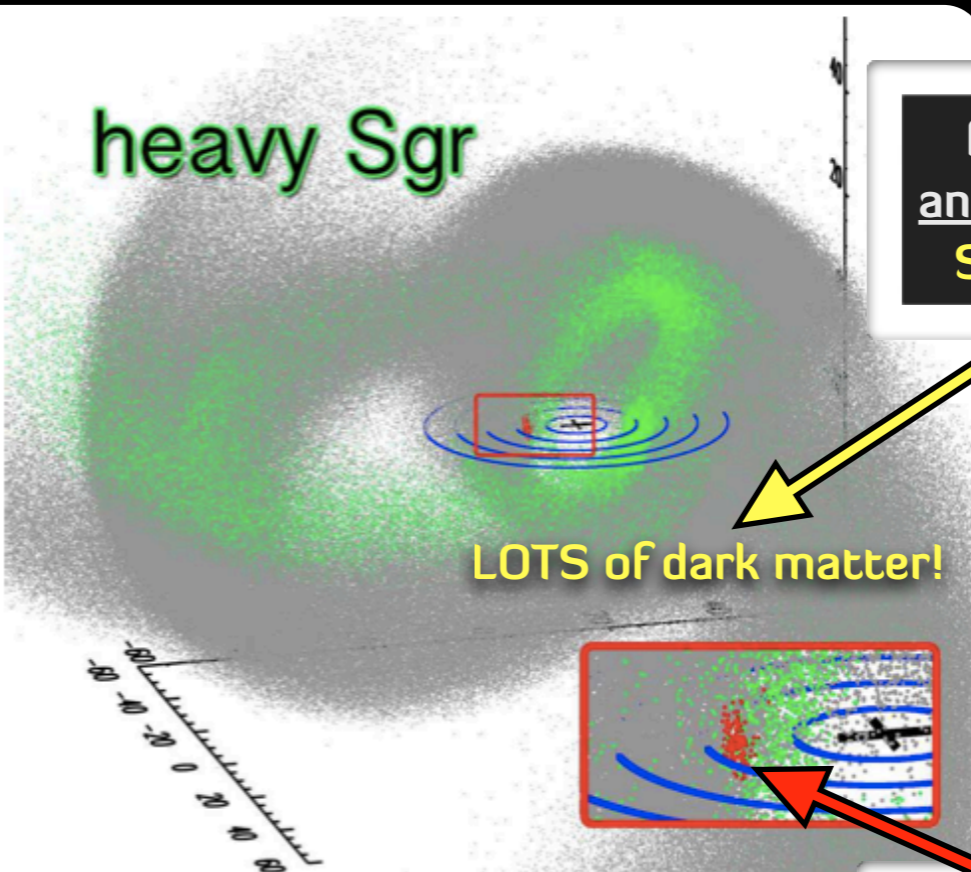
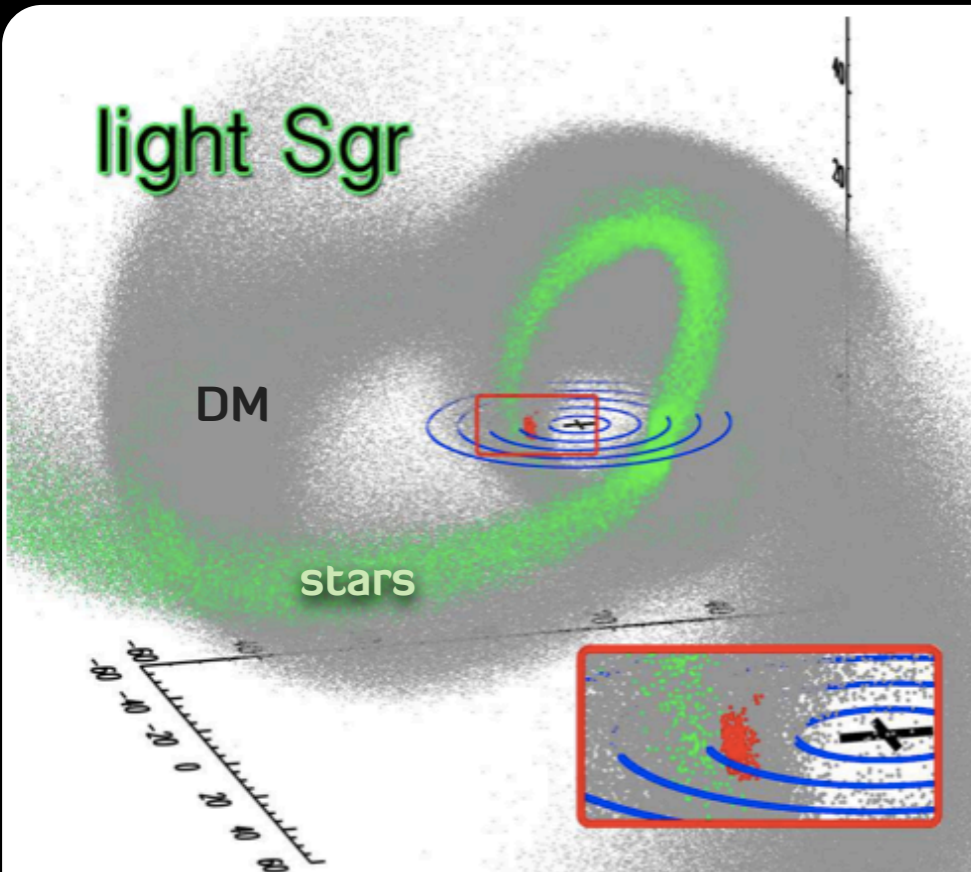
The **Sagittarius Impact** as an Architect of **Spirality** and **Outer Rings** in the **Milky Way**



outer rings from spiral wrappings

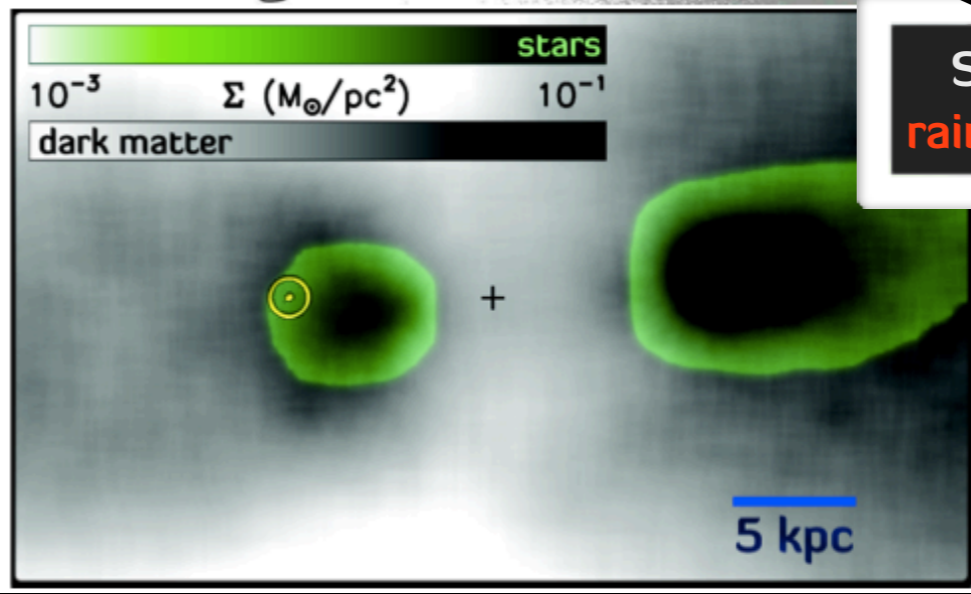
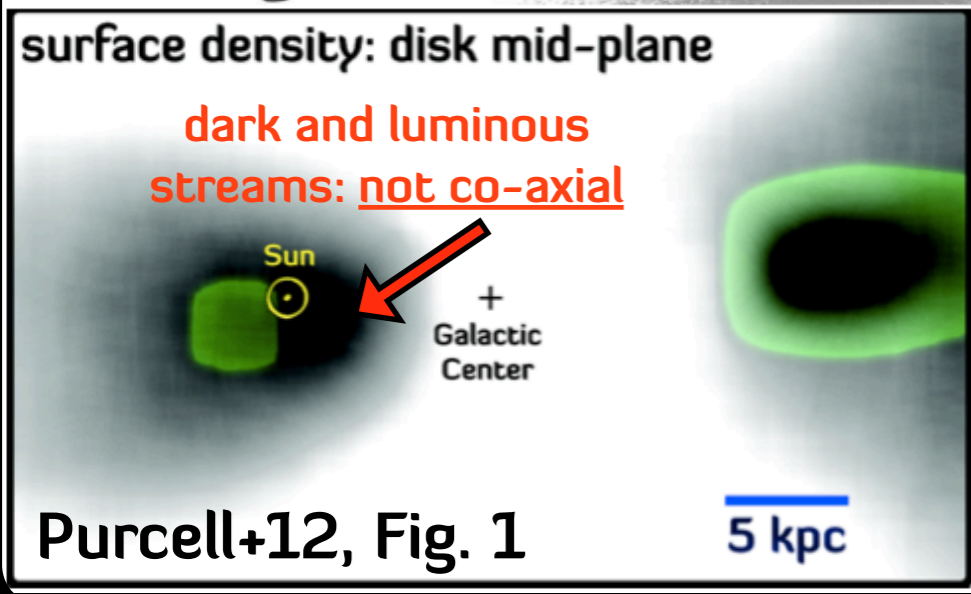
stream of tidal debris from Light Sgr dwarf satellite galaxy

Sagittarius Debris at Earth



from cosmological context and kinematic reconstructions:
Sgr progenitor was massive

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

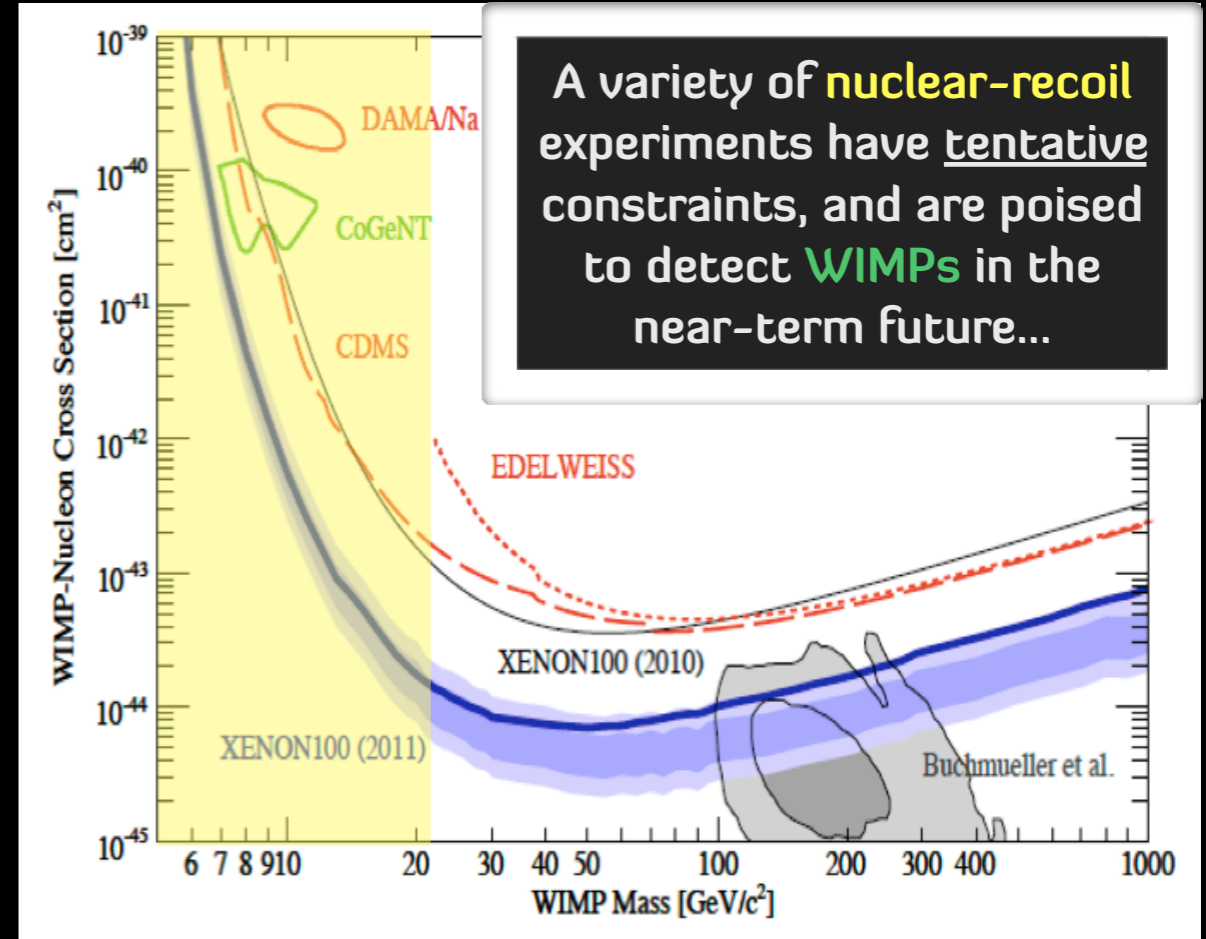
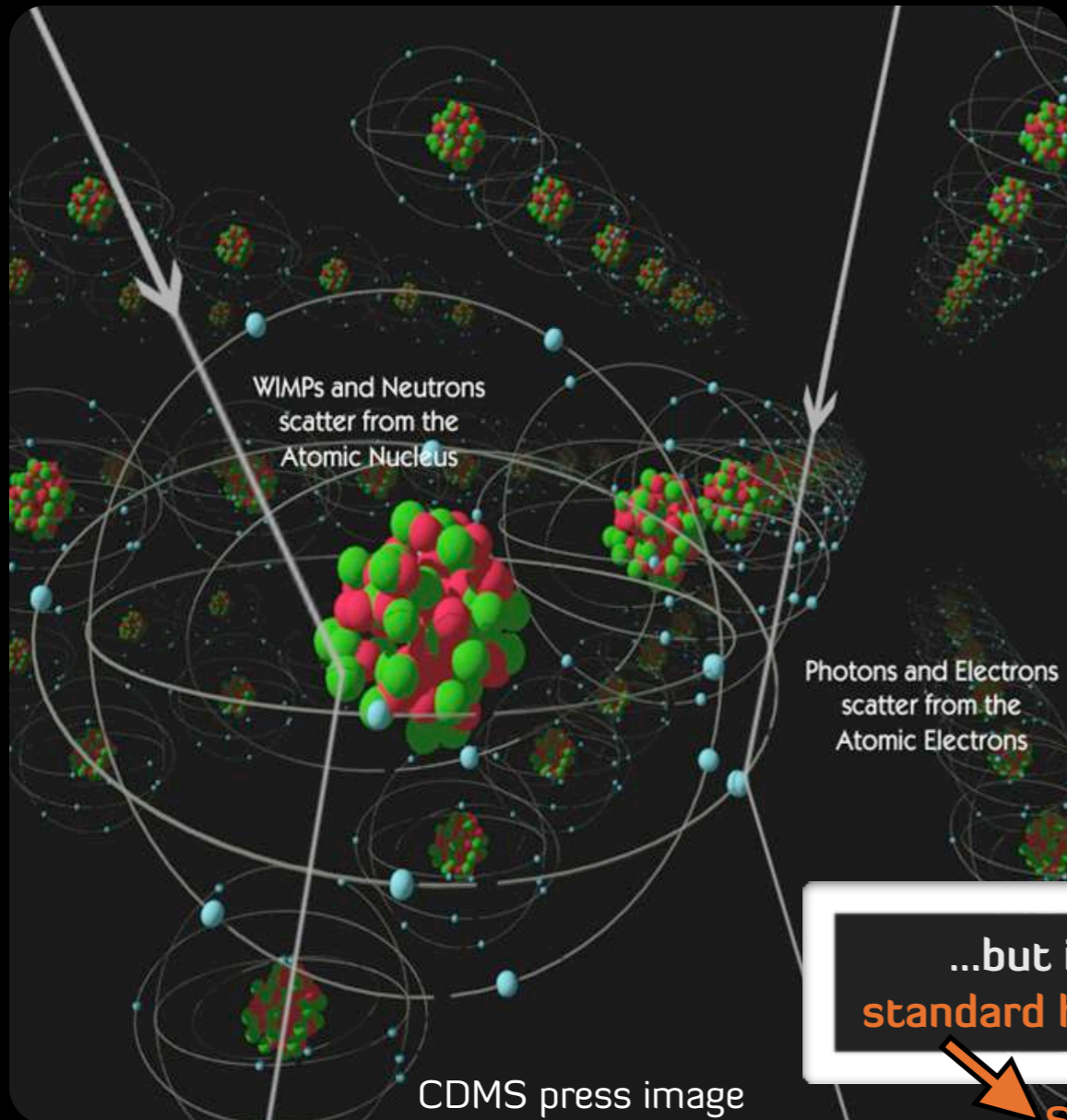


Sgr dark matter tidal arm is **raining directly onto the Earth...**

...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 ~ 100 pc of Sun:
 e.g. Helmi et al. 2006; Re Fiorentin et al. 2011

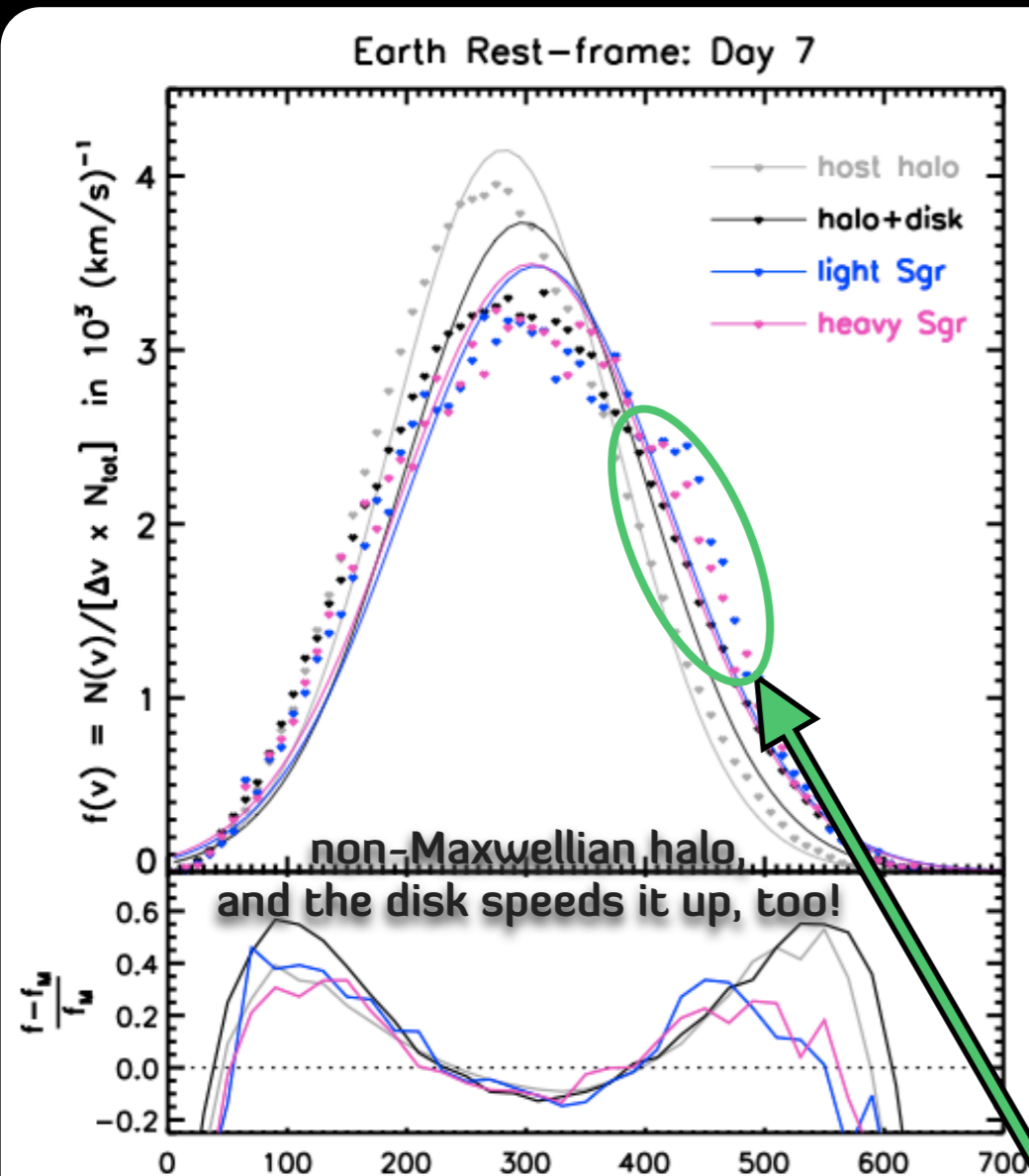


A variety of **nuclear-recoil** experiments have tentative constraints, and are poised to detect **WIMPs** in the near-term future...

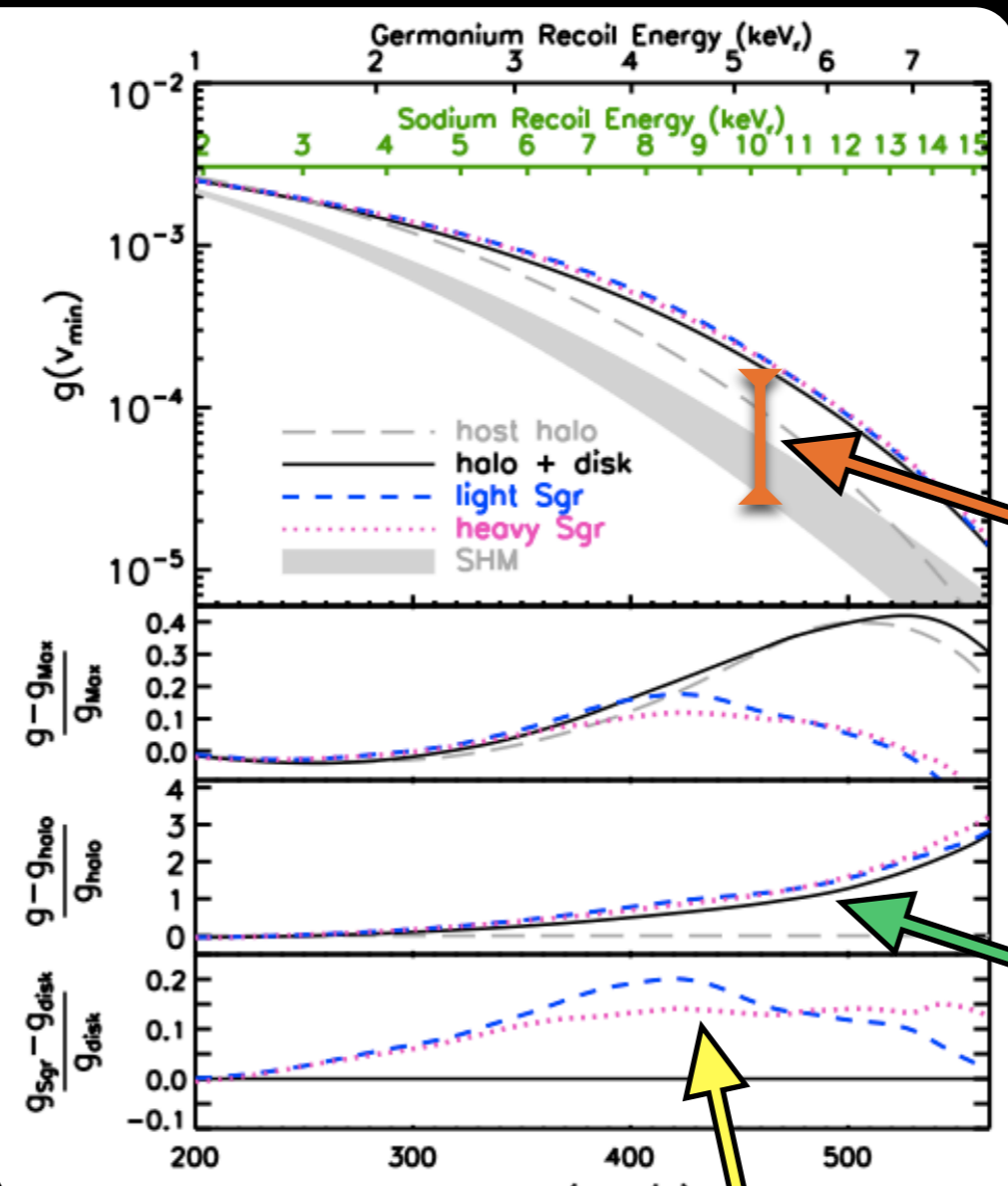
...but interpretations of the event rates typically assume a **standard halo model** of the **local speed distribution of dark matter!**

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

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



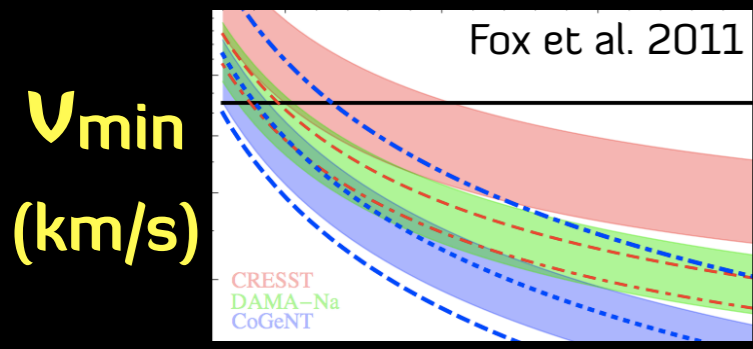
Purcell+12, Fig. 2



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

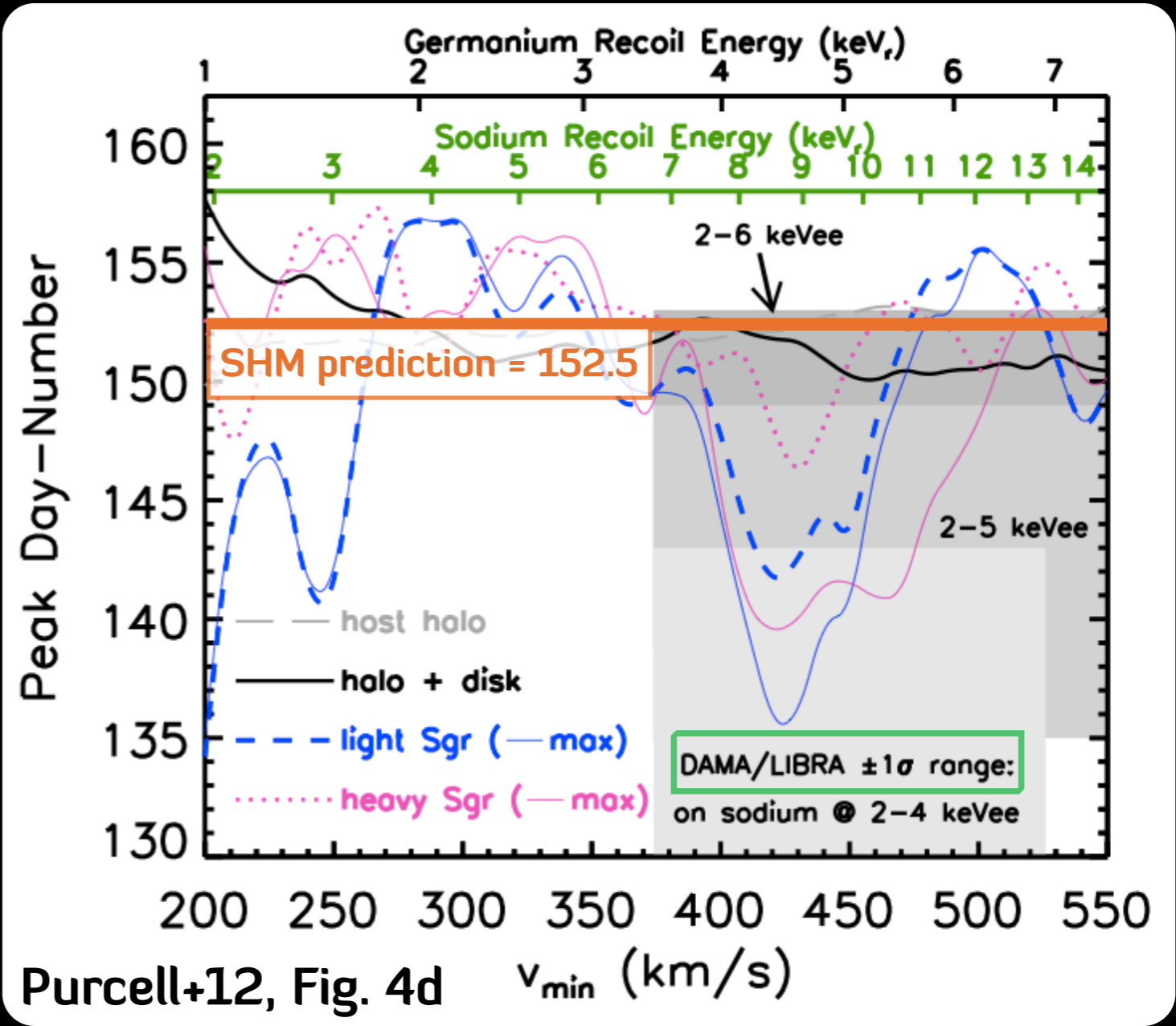
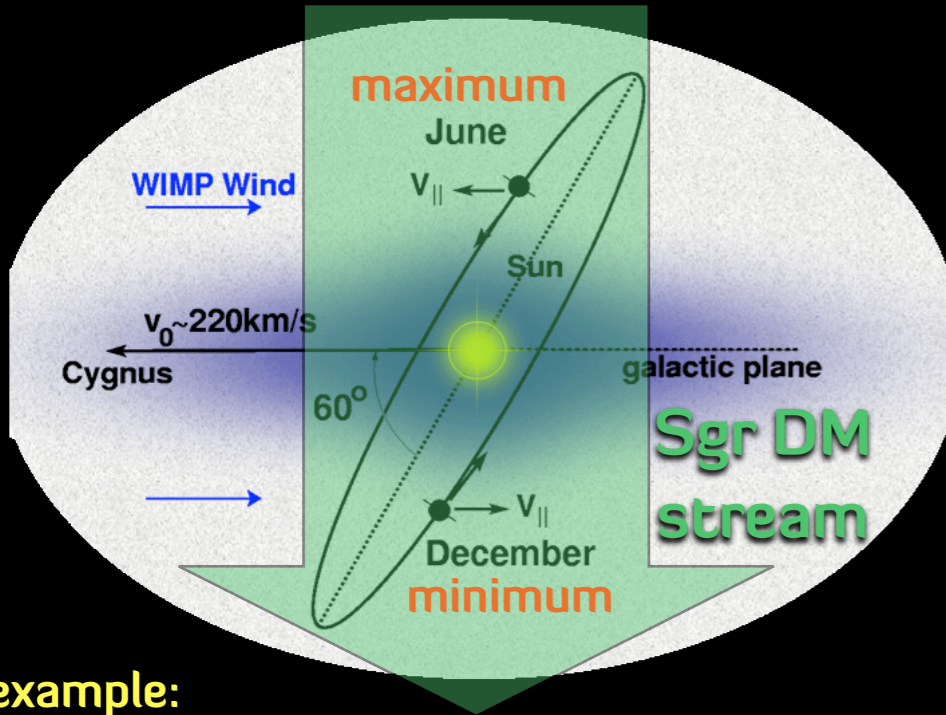
standard halo model underestimates event-rates by a factor of >2-5!

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



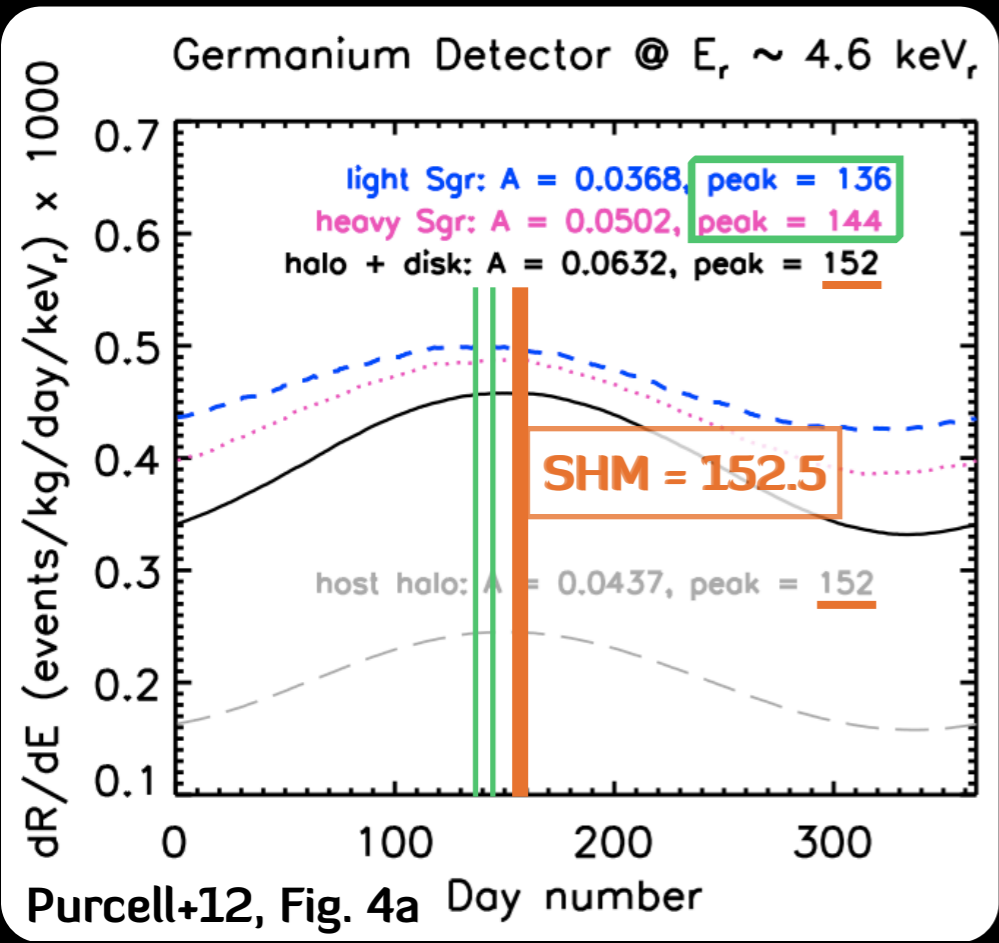
$M_X \text{ (GeV/c}^2\text{)}$

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. 4d

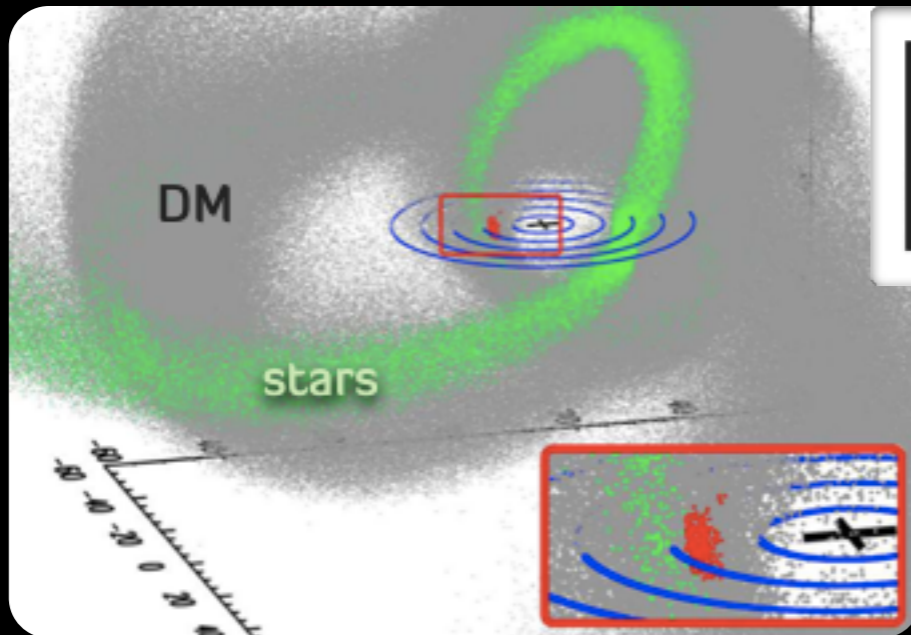
example:



Purcell+12, Fig. 4a

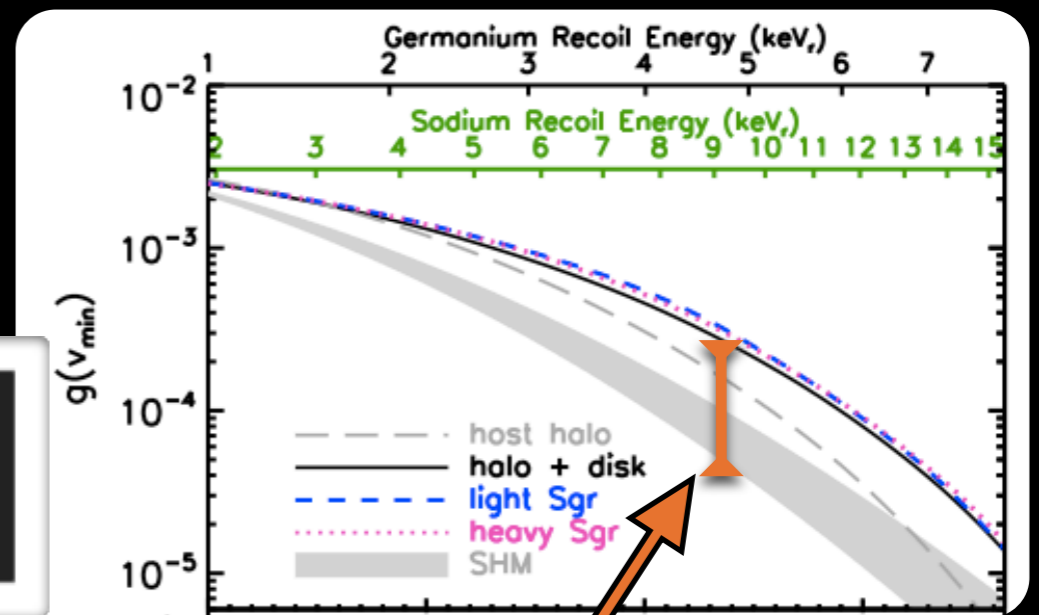
Only **significant debris flows** (and not ancient micro-streams) can drag the peak away from the **SHM-predicted value** by several days...

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

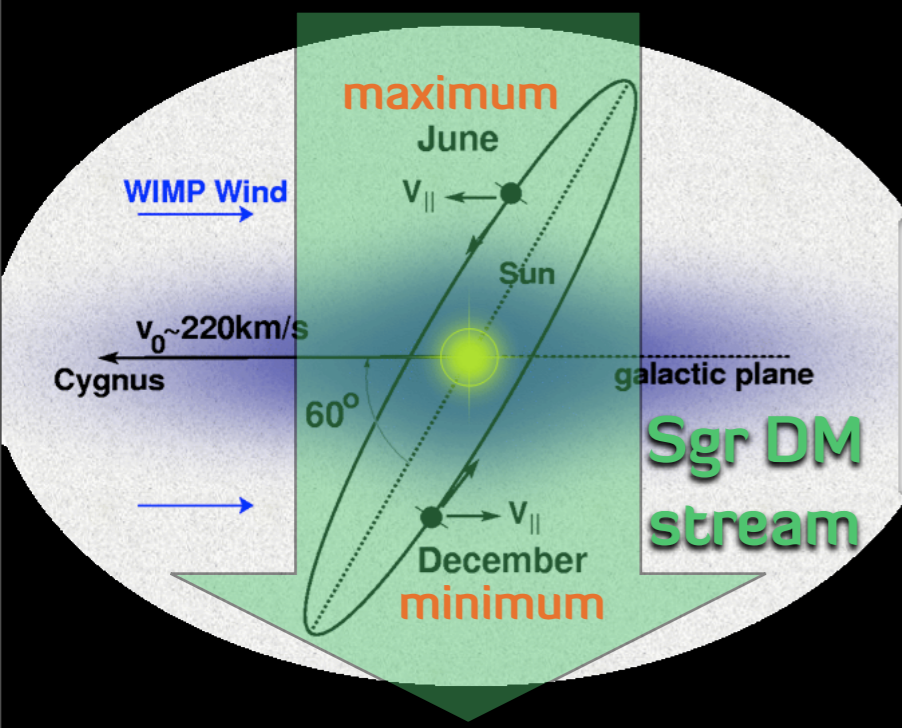


Dark matter from the **disrupting Sagittarius dwarf** is raining onto Earth at the solar neighborhood, and induces a **~10-20% boost** in recoil-event rates

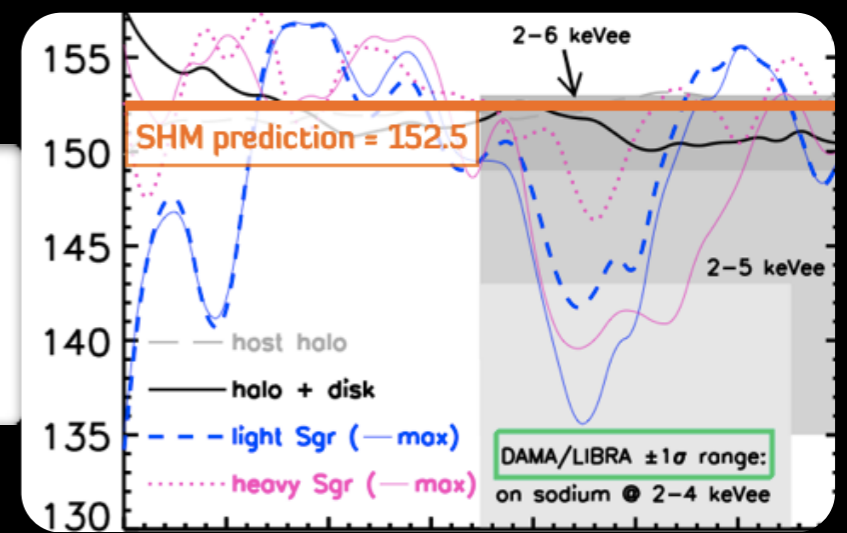
Self-consistent mapping from **N-body halo rates** (e.g. for VL2, Aquarius) to those predicted for same halos with **realistic Galactic disks**: important on **factor of ~2 level**



...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!