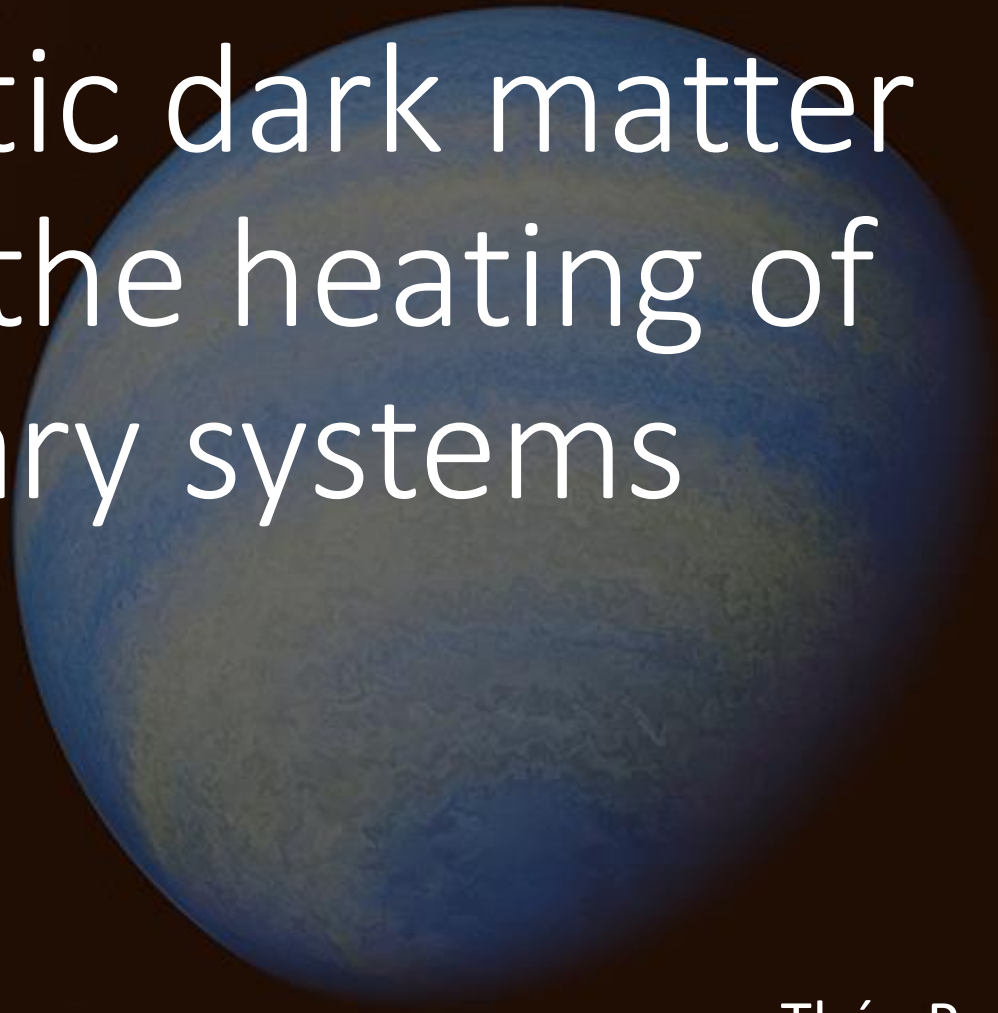
Probing Galactic dark matter objects from the heating of exoplanetary systems



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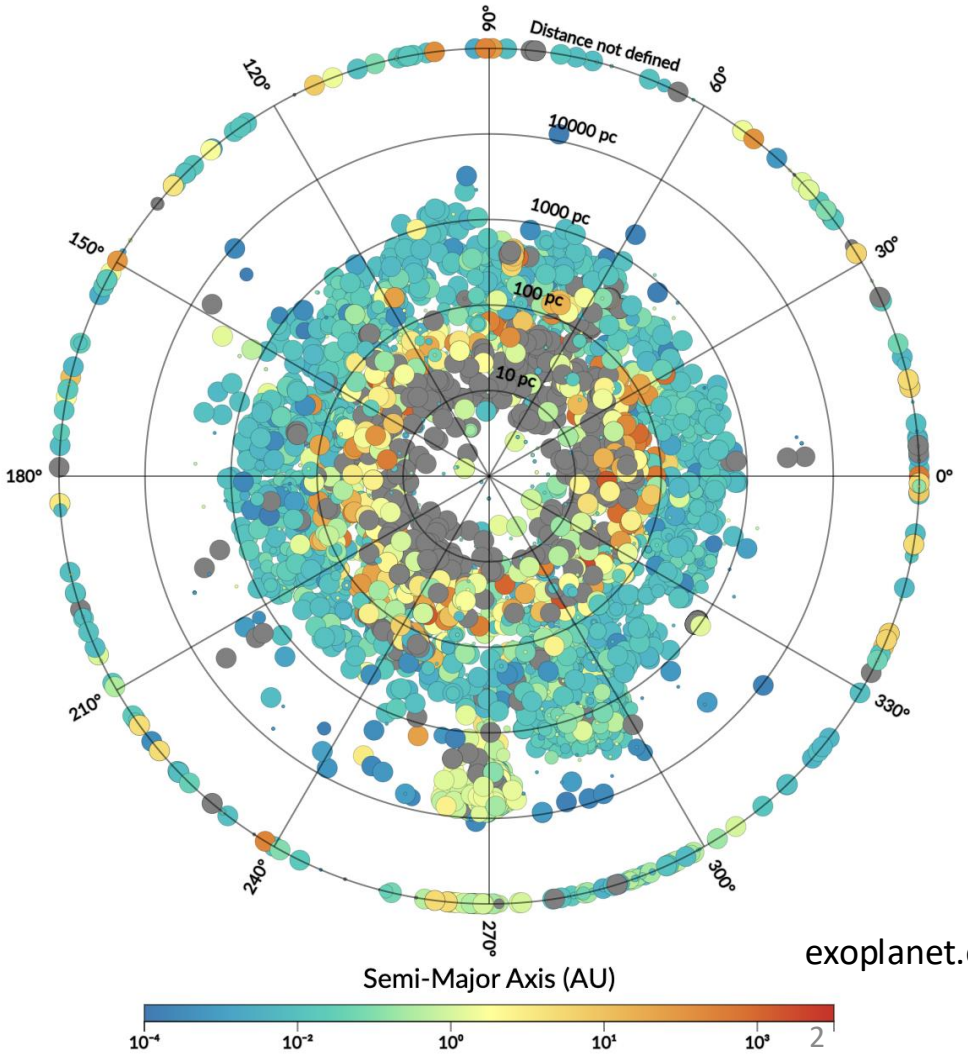
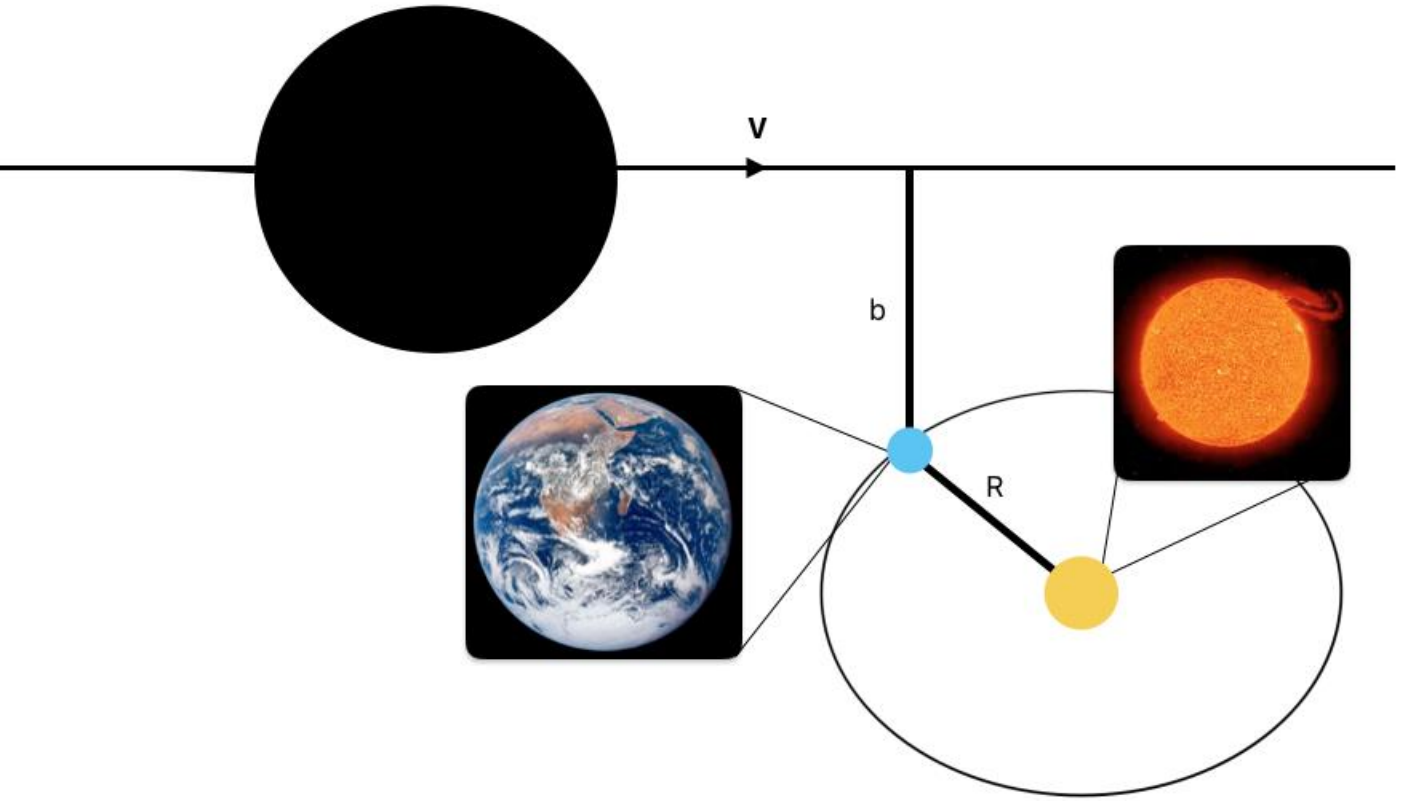
Motivations

- Rather good understanding of DM distribution on galactic scales and larger but not many probes of subgalactic scales
- Small scales halos are very dependant on the nature of DM and the initial condition from inflation
- Exoplanets are a small scale system and can gravitationally probe subhalos
- More than 7000 exoplanets detected



exoplanet.eu

Exoplanet encounters



- Impulsive approximation:

$$T_{\rm enc} < P \iff b_{\rm max} = \frac{VP}{2}$$

- Halo not gravitationally bound:

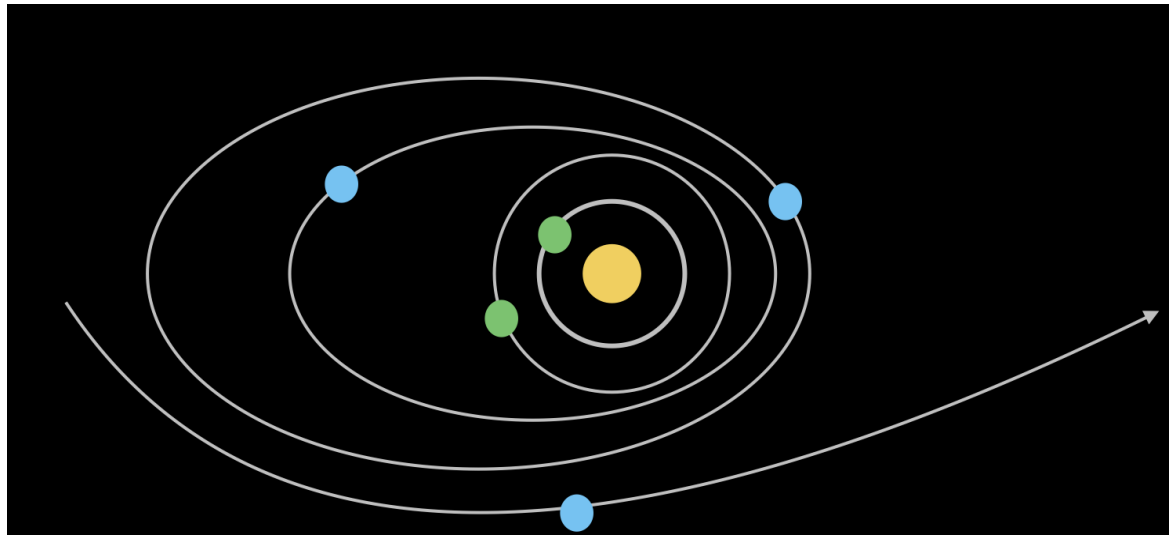
$$b_{\rm min} = \frac{GM_{DM}}{V^2}$$

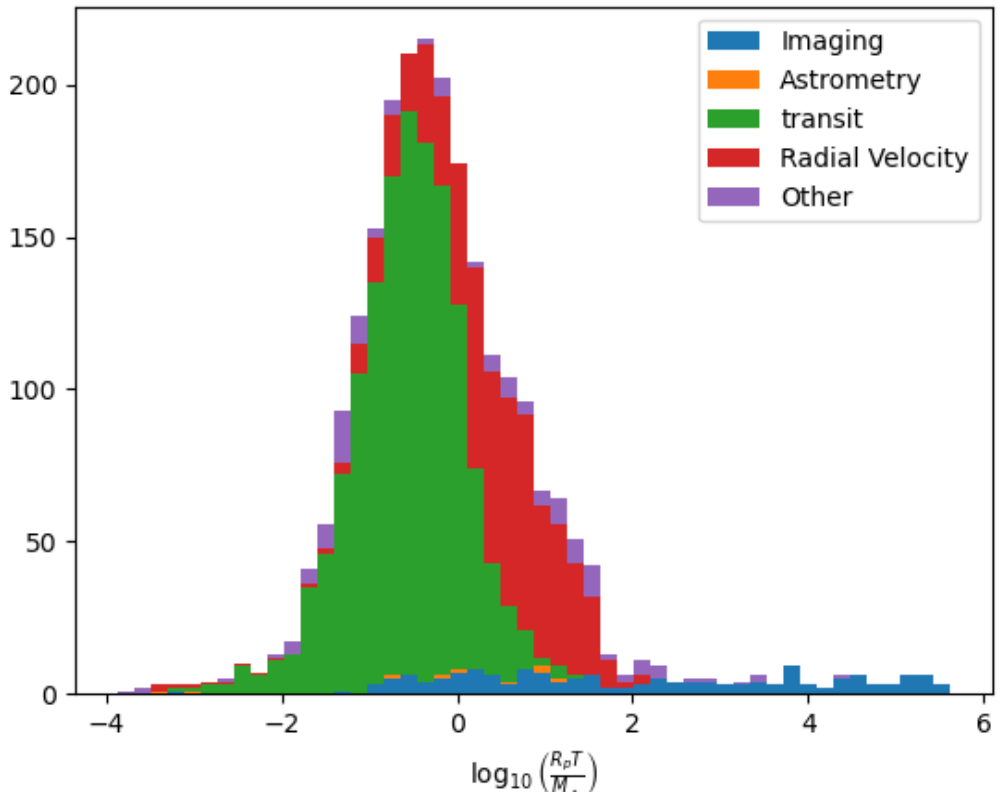
Heating rate

- Velocity kick for one collision : $(\Delta v)^2 = \left(\frac{2GM_{\rm DM}}{Vb}\right)^2 \frac{2R^2}{2R^2+3b^2}$
- Total heating rate : $\mathcal{H} = \frac{2\sqrt{2}G^2 M_{\rm DM}\rho_{DM}}{\sigma_{\rm DM}} \ln\left(\frac{3+2(R/b_{\rm min})^2}{3+2(R/b_{\rm max})^2}\right)$
- Two asymptotic regimes:
  - $b_{\rm min} \ll R \Rightarrow \ln\left(\frac{3+2(R/b_{\rm min})^2}{3+2(R/b_{\rm max})^2}\right) \sim \ln\left(\frac{R}{b_{\rm min}}\right)$
  - $b_{\rm min} \gg R \Rightarrow \ln\left(\frac{3+2(R/b_{\rm min})^2}{3+2(R/b_{\rm max})^2}\right) \sim \left(\frac{R}{b_{\rm min}}\right)^2$

Observable

- Relative energy injection : $\frac{E_{\mathrm{inj}}}{|E|} = \frac{\mathcal{H} T R}{G M_\star}$
- Orbital radius range can vary from 10^{-3} a.u. to 10^{4} a.u.
- Orbit eccentricity increases
- Orbital plane inclination changes
- Planet ejection

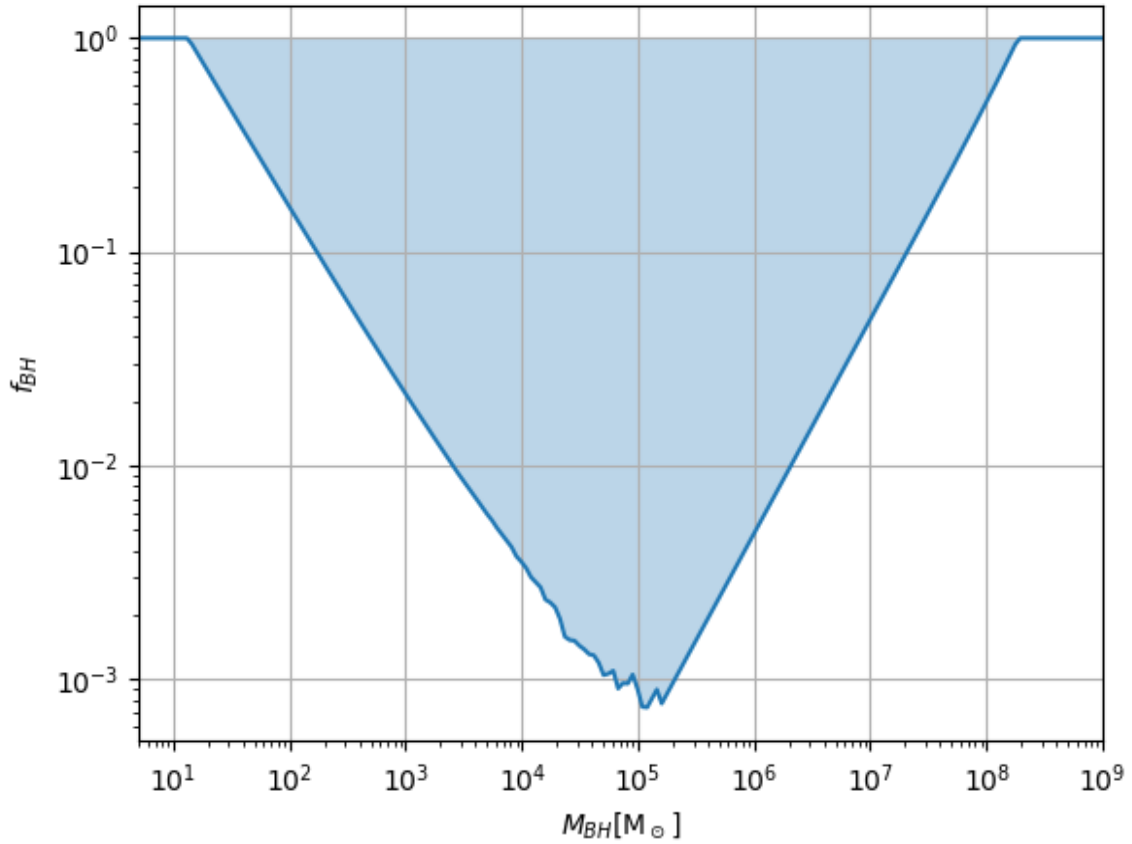




Data from exoplanet.eu

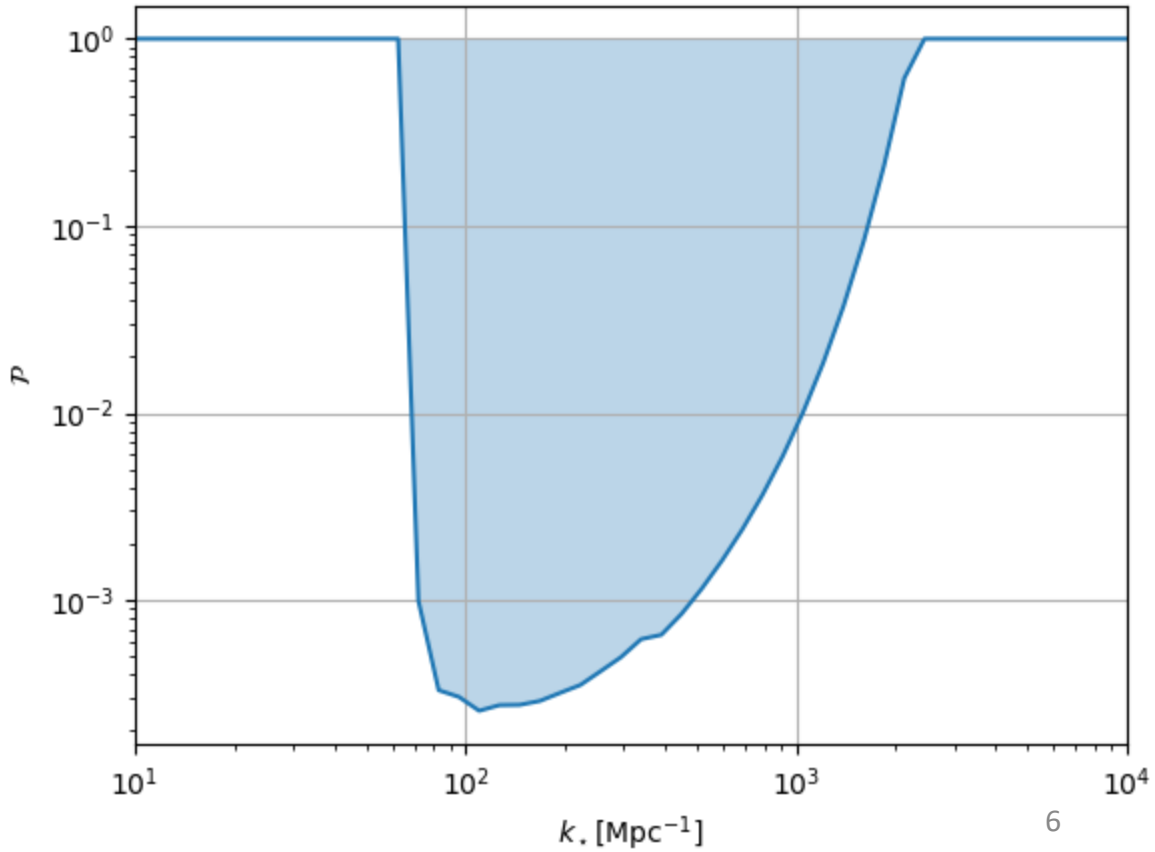
Preliminary results

Primordial black holes



Ultra-compact minihalos

$$\mathcal{P} = \mathcal{P}_{\mathrm{PL}} + \mathcal{A}_\star k_\star \delta(k - k_\star)$$




Thank you for your attention