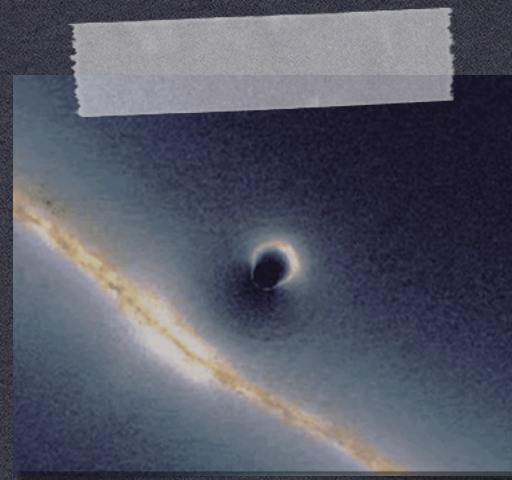


ABUNDANCE OF LIGO/VIRGO BLACK HOLES FROM QUASAR MICROLENSING

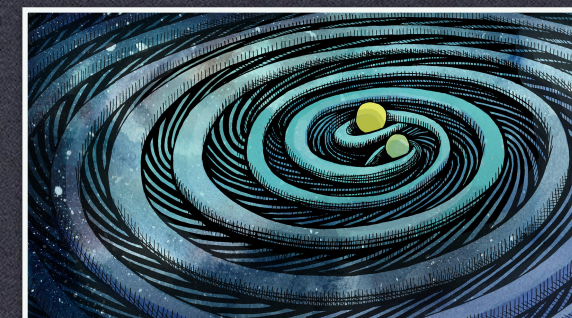
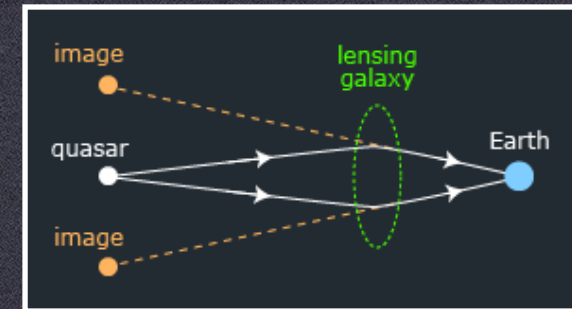


ANA ESTEBAN GUTIÉRREZ - IAC/ULL

INVISIBLES21 WORKSHOP- 31ST MAY/ 4TH JUNE 2021

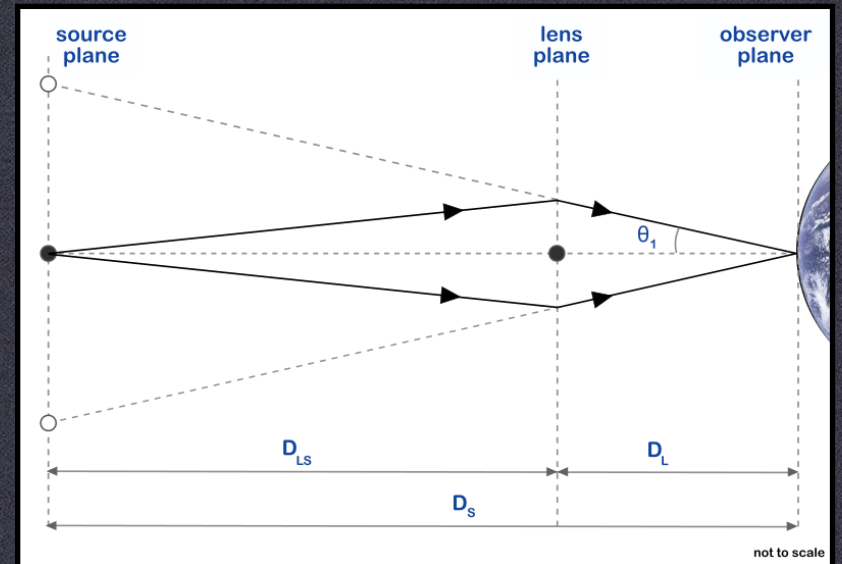
Introduction: PMBHs as DM?

- * **Quasar microlensing** as a tool to extract properties of any population of compact objects in the lens galaxy.
- * Does the Primordial Massive Black Holes (PMBHs) constitute a **fraction of the Dark Matter (DM)**?
- * **LIGO/Virgo**: recent data show unexpected BH mergers with low spin and unusual masses.
- * Could these PMBHS be hidden within a **population of compact objects** in the lens galaxies (i.e. stars...)?

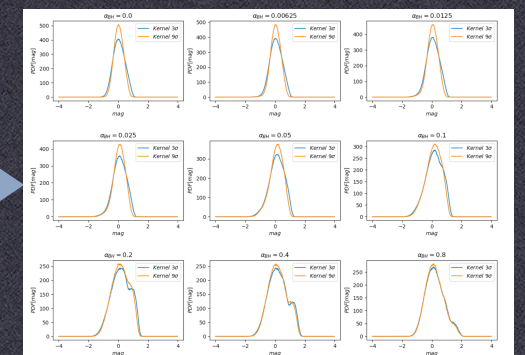
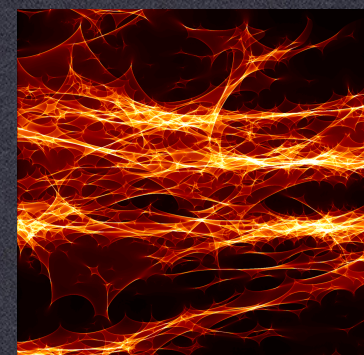
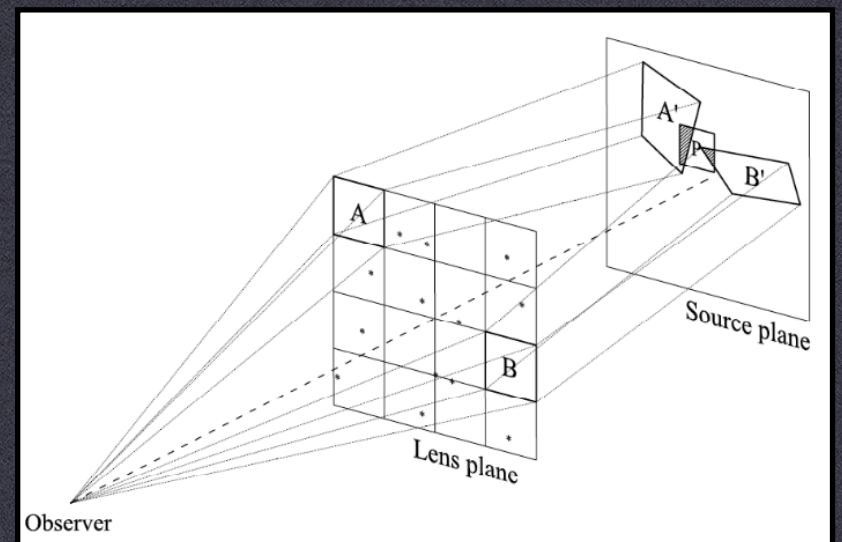


Methodology

- * Microlensing flux magnification — (stars of $0.2M_{\odot}$ and BHs of $30M_{\odot}$) and a smooth matter component.
- * Simulated microlensing maps — Inverse Polygon Mapping (IPM) algorithm & SLURM software.
- * Obtaining the Probability Density Functions (PDFs) — Bayesian statistics with a set of optical magnitudes from gravitational microlensing observations.



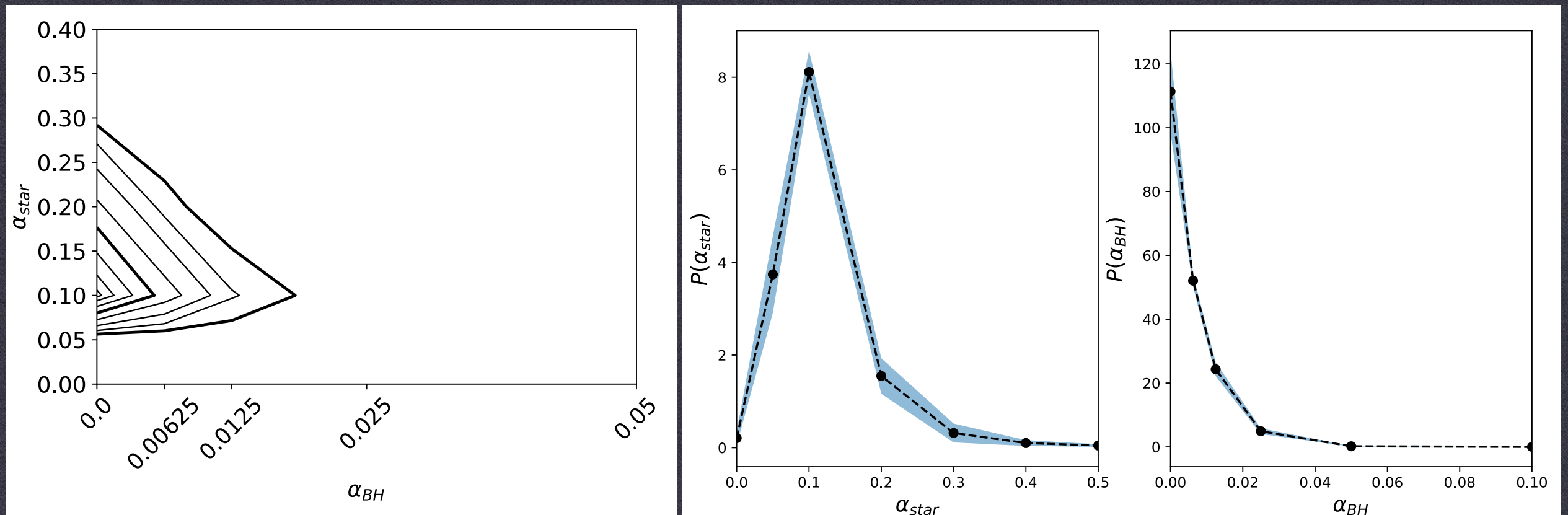
$$\theta_E = \left(\frac{4GM D_{OL} D_{LS}}{c^2 D_{OS}} \right)^{\frac{1}{2}} = \text{Einstein radius}$$



Results (II)

(*) The blue shadowed region defines the standard deviations corresponding to lens model uncertainties estimated from a bootstrapping analysis.

(Notice that $\alpha_{stars} + \alpha_{BH} + \alpha_{smooth} = 1$)



We estimate a **13% contribution from the stars**, in agreement with previous studies based on a single mass population that do not consider explicitly the presence of BHs. *The 2D joint PDF* shows a maximum at **$\sim 10\%$ of stars with zero contribution from the BHs.** (*)

According to the marginalized *1D PDF of BHs*, only a very small fraction of the total matter, **$\alpha_{BH} \lesssim 0.01$** at 68% of confidence (**$\alpha_{BH} \lesssim 0.02$** at 90%) for **$M_{BH} \sim 30M_{\odot}$** is expected.

Conclusions

Upcoming work



- * A significant contribution from **very small BHs** mixed within the stars cannot be discarded.
- * We are currently studying the effect of considering a **mixed population of stars and PBHs of less than $10M_{\odot}$** and we expect to compare these results with the X-ray band observed magnitudes.

SO...STAY TUNED FOR MORE INTERESTING RESULTS!

**THANKS FOR
YOUR ATTENTION !**

