Free Floating Planets in M22?
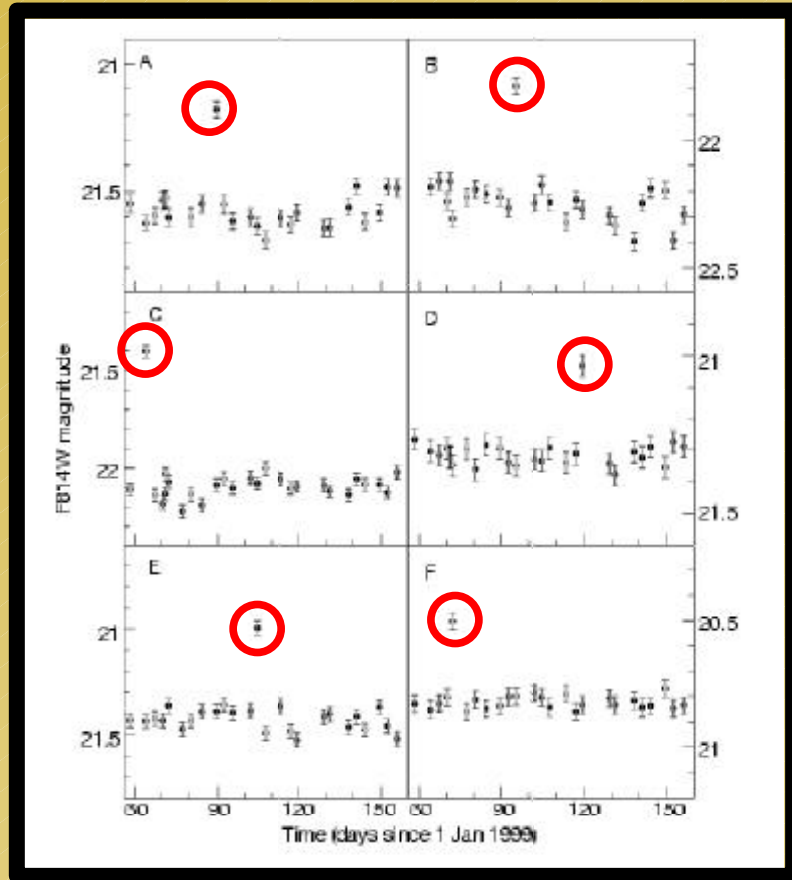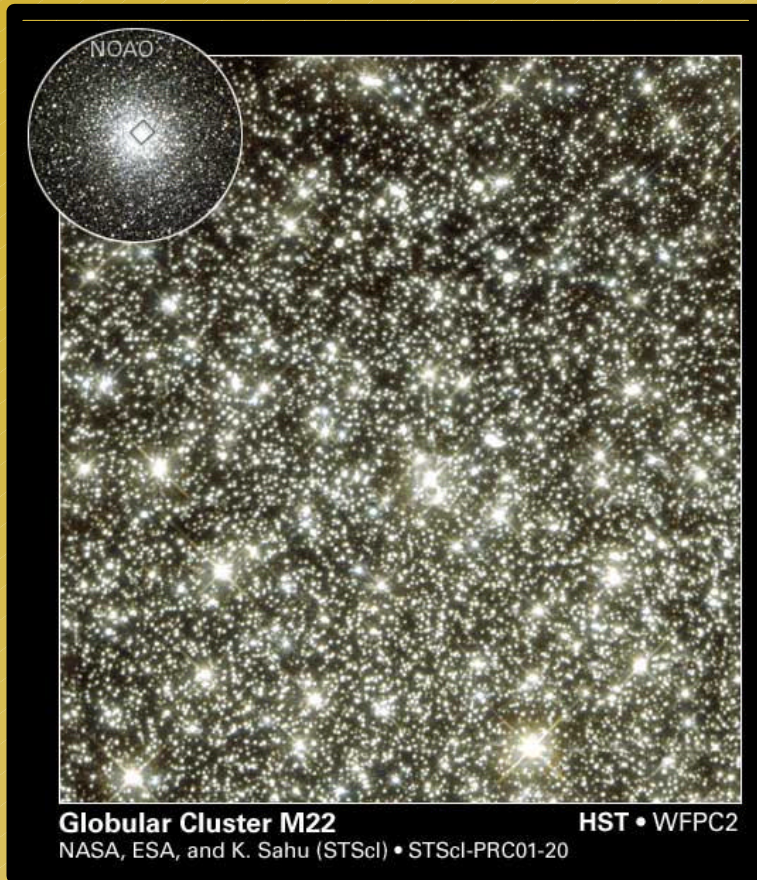
B. Scott Gaudi
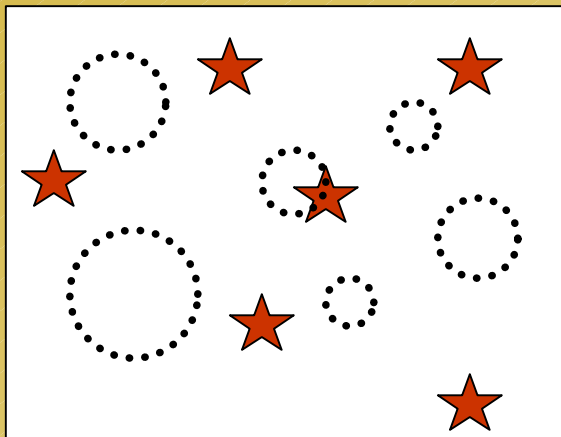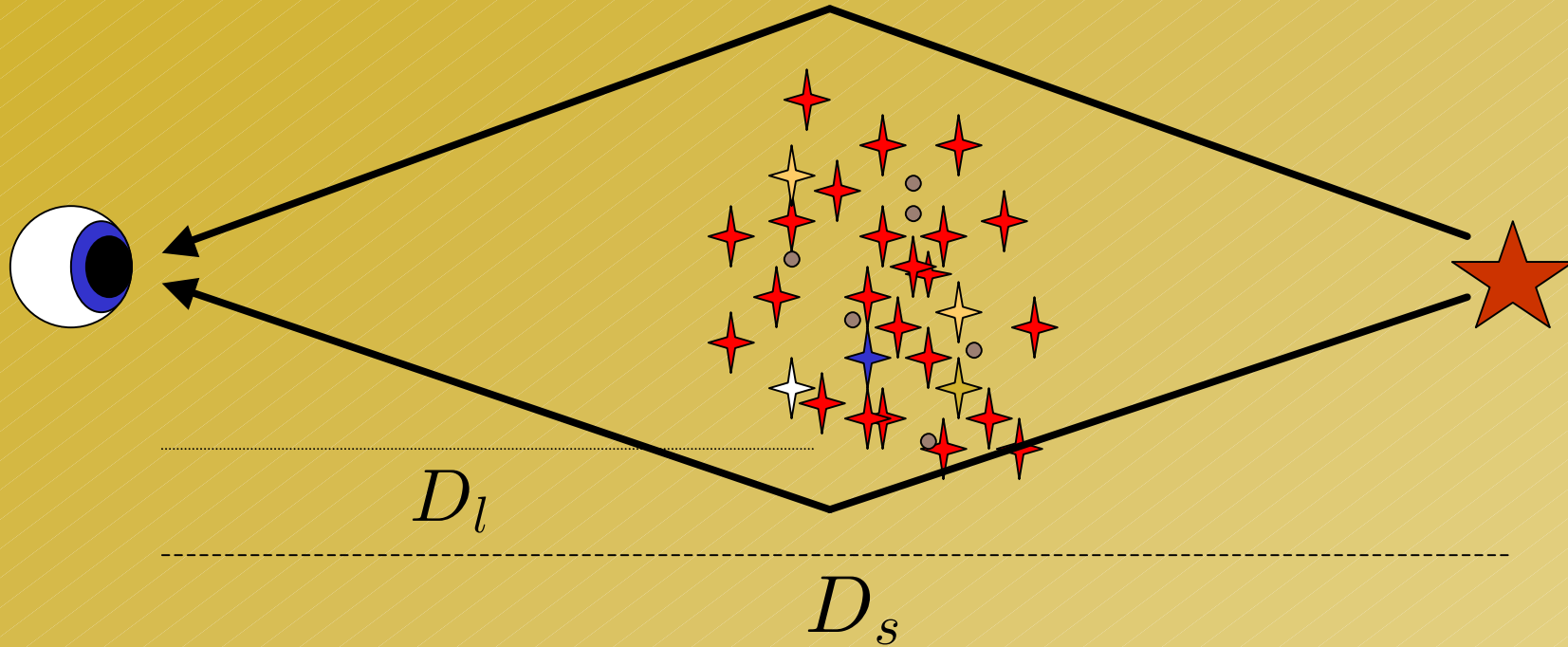## Institute for Advanced Study

Gravitational Microlensing by Low-mass Objects in M22
Sahu et al. 2001, Nature, 411, 1002

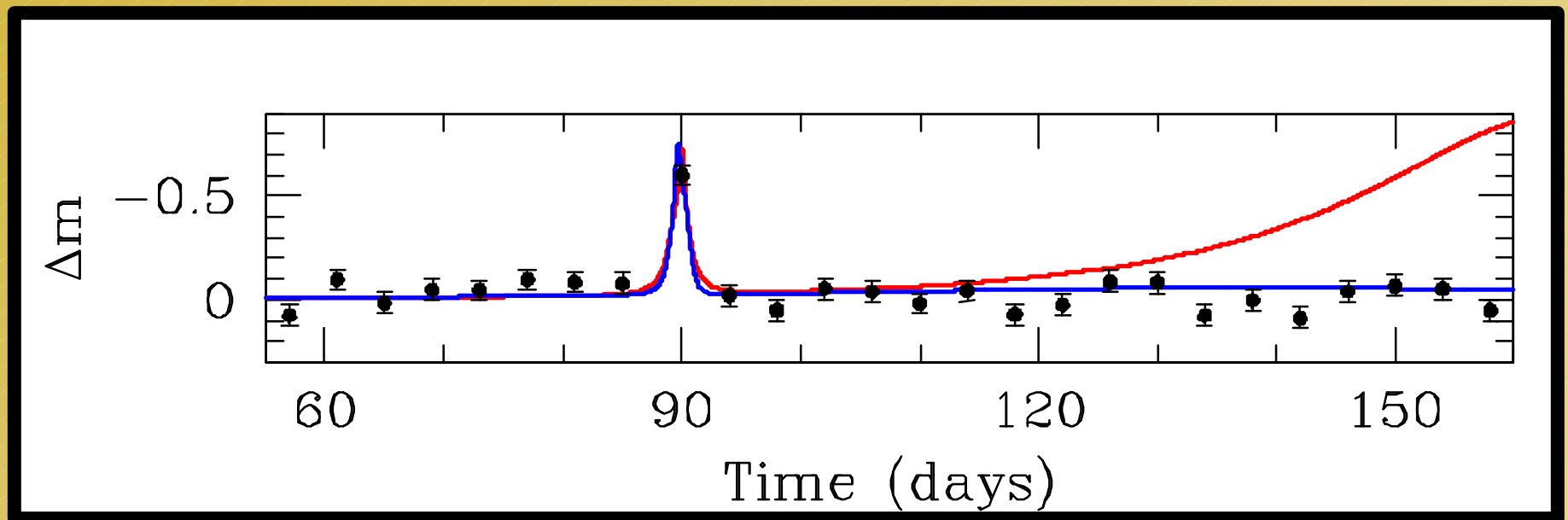$$\tau \simeq \frac{N_{spike}}{N_* N_d} = (2.9 \pm 1.2) \times 10^{-6}$$
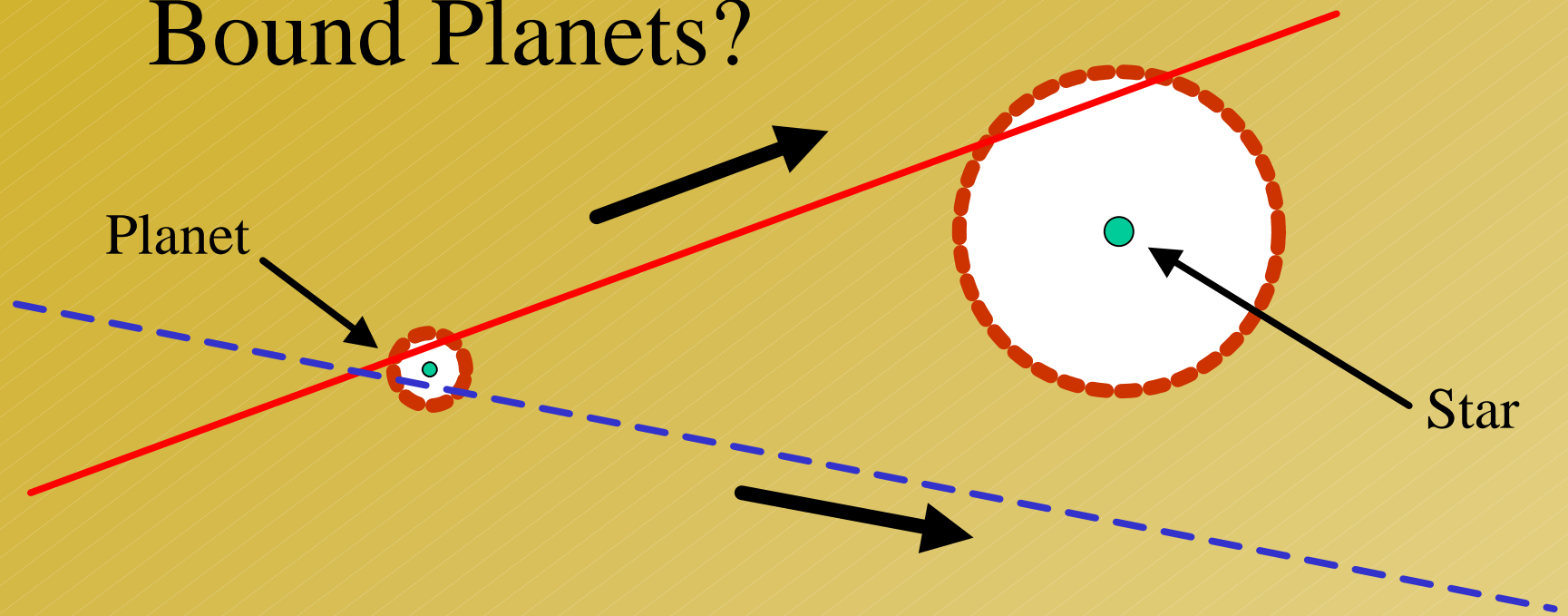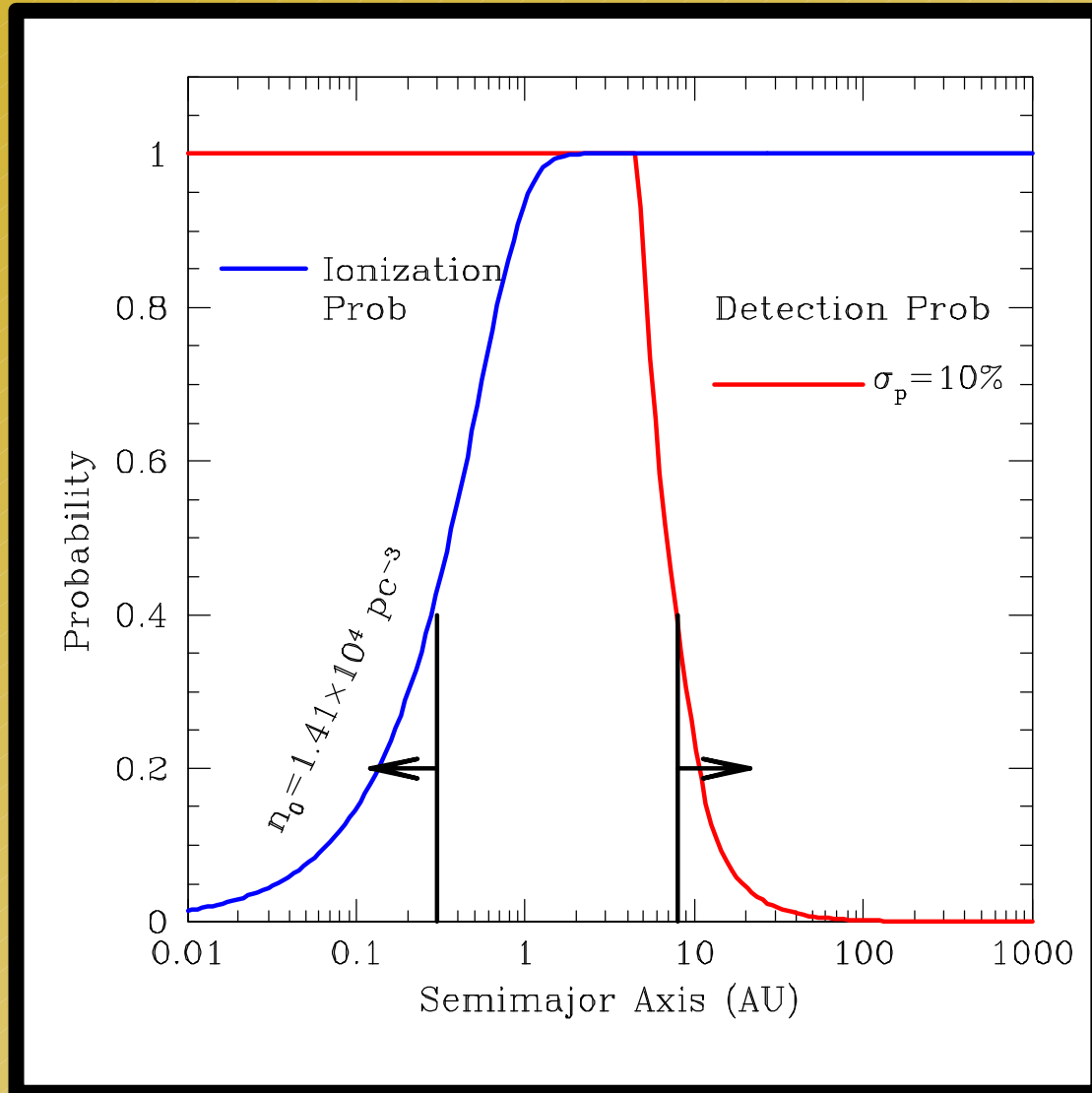
Optical Depth to Lensing

$$\tau = \frac{4\pi G \Sigma D_s}{c^2} x(1-x) \qquad x \equiv \frac{D_l}{D_s}$$

$$\tau_p = \frac{M_p}{M_*} n_p \tau_* \approx 10^{-8} n_p$$

Bound Planets?

Planet

Star

Parent Detection Probability

Planets must be separated by a > 8 AU.

Ionization Probability

Encounter
Timescale ➡ $t_{enc} = \left[16\sqrt{\pi}\,\nu\sigma a^2 \left(1 + \frac{GM_*}{2\sigma^2 a} \right) \right]^{-1} \simeq 4.3\text{Gyr}$

Ionization
Probability ➡ $P_{ion} \simeq 1 - e^{T_0/t_{enc}}$

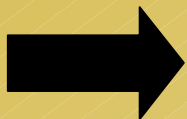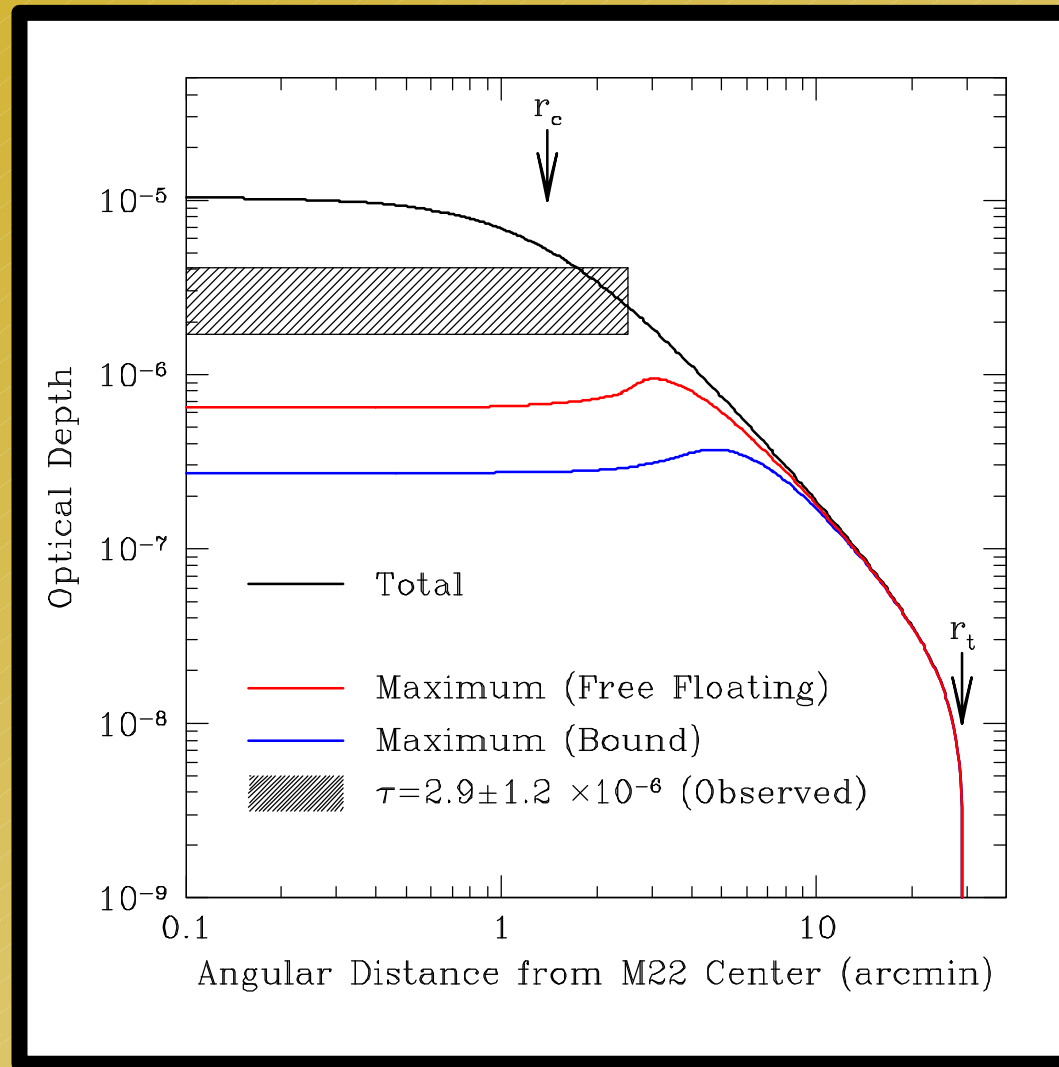Planets must be separated by a < 0.3 AU in core.

➡ Not Bound

Free Floating?

System will be driven to equipartition $\blacktriangleright$ $\sigma_p^2 \sim \dfrac{M_*}{M_p}\sigma_*^2$

Evaporation
Timescale $\blacktriangleright$ $t_{relax} = 0.065\dfrac{\sigma^3}{\nu M_*^2 G^2 \ln \Lambda} \simeq 0.33\mathrm{Gyr}$

$\blacktriangleright$ **Not Free Floating**

Planets in M22 Halo?

Planets in M22 cannot explain events

Summary:

- Planets in M22 cannot explain events.

- Cannot be Galactic planets (Galactic structure).

- Either dark cluster of planets, or not microlensing.

Conclusion:

➡ Not Lensing, Cosmic Ray Hits