



地球 Earth 月球 Moon

SgrA* spin and mass estimates through the detection of an extremely large mass-ratio inspiral

水星 Mercury 太阳 Sun

arXiv:2206.14399 (Accepted by ApJ)

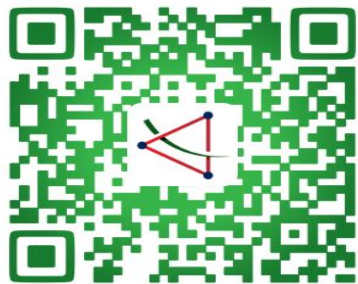
Alejandro Torres-Orjuela • Veronica Vazquez-Aceves & Yiren Lin
 HKU , June 26, 2023

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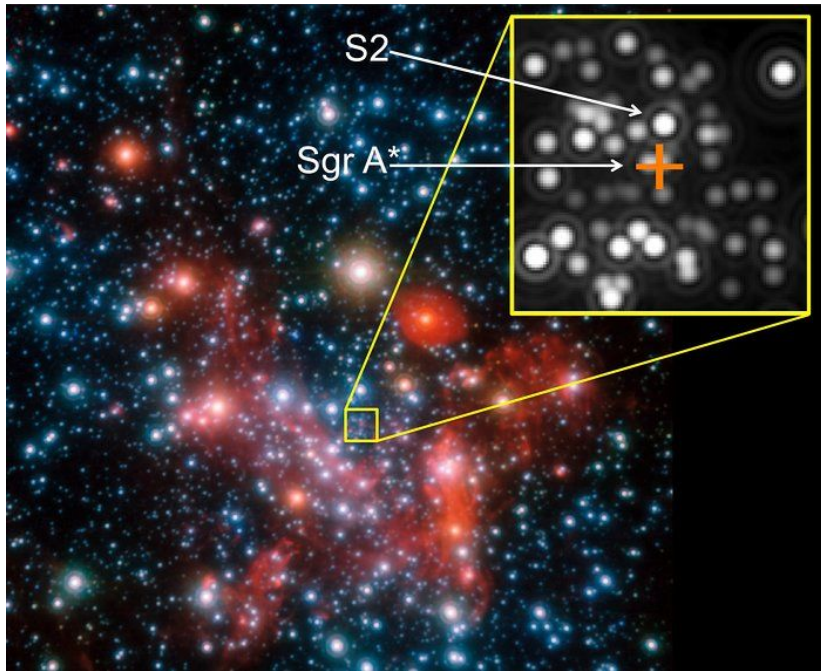
激光测距台站

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Studying our galactic center: SgrA*

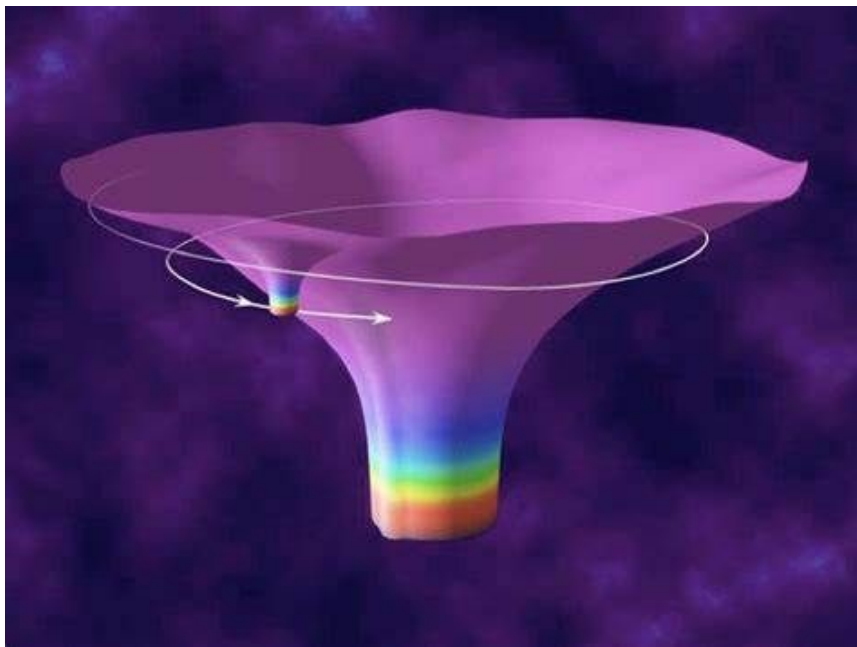
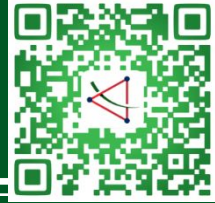


Credit: ESO Very Large Telescope

- Want study SgrA* to:
 - Study SMBHs
 - Understand evolution of galaxies
 - Test GR
 - ...
- E.g., S2 to test GR:
 - Radius $\approx 2900 R_S$
 - Orbital period ≈ 16 yr



Extremely large mass-ratio inspirals (XMRI)



Gravitational potential of a small compact object around a SMBH

- XMRI := **BD orbiting SMBH:**
 - Radius $\sim 1 R_s$
 - Orbital period \sim min to hr
- Small BD mass \rightarrow Weak GWs:
 - **Only detectable nearby**
 - **Evolve very slow**



XMRI detection rate



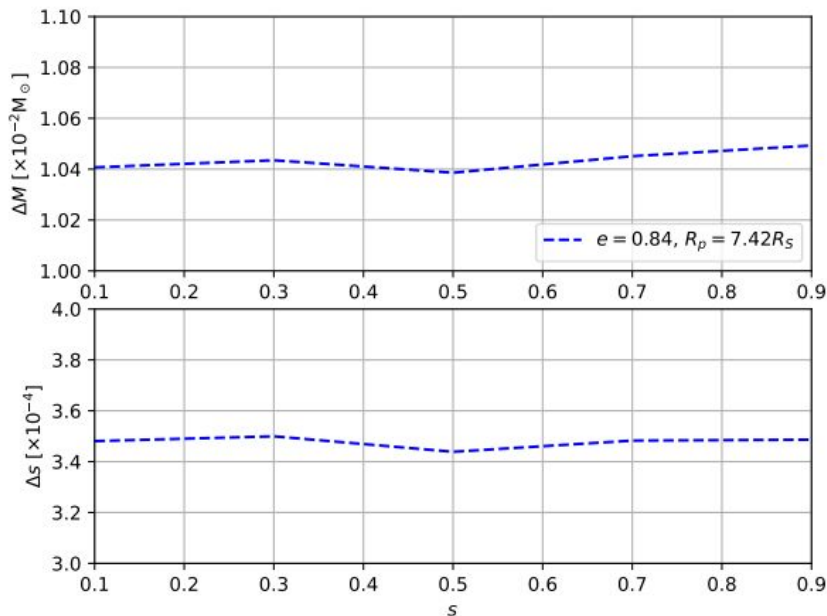
SgrA* spin	\bar{N}_I	\bar{N}_{II}
0.1	0	8^{+9}_{-3}
0.9	1	12^{+6}_{-4}

Number of circular (I) and eccentric (II) XMRI in band.
[Vazquez-Aceves+2022]

- XMRI form at rates similar to EMRI but stay much longer in band!
- Expect **one circular XMRI** for high spins (SNR ~1000)
- Expect **multiple eccentric XMRI** (SNR ~30)



Mass and spin: eccentric XMRI

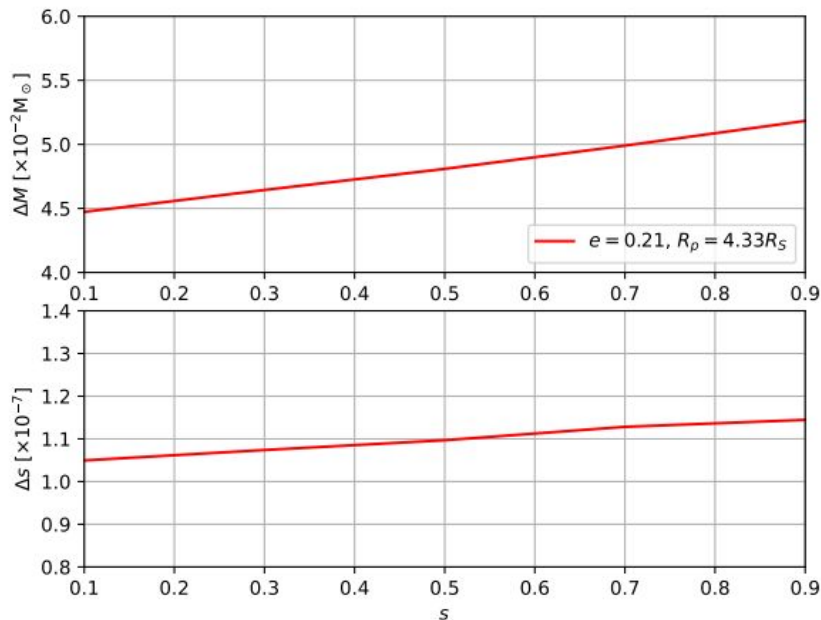


- With a single *eccentric* XMRI:
 - $\Delta M \sim 10^{-2} M_{\text{sun}}$
 - $\Delta s \sim 10^{-4}$

Mass and spin accuracy for different spins [Vazquez-Aceves+2022]



Mass and spin: circular XMRI

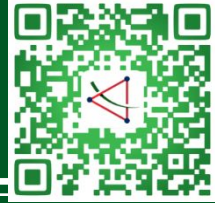


- With a single *circular* XMRI:
 - $\Delta M \sim 10^{-2} M_{\text{sun}}$
 - $\Delta s \sim 10^{-7}$

Mass and spin accuracy for different spins [Vazquez-Aceves+2022]



Summary



- XMRIs are **guaranteed sources around SgrA*** → up to tens in band
- Due to proximity **very high SNR of up to 1000s**
- Test mass and spin of SgrA* with unprecedented accuracy: $\Delta M \sim 10^{-2} M_{\text{sun}}$ and $\Delta s \sim 10^{-4} - 10^{-7}$
- Future: **Exploit high number and SNR of sources**, e.g., tests of GR, study environment, improved measurements of SgrA*...



Thanks for your attention !

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