Telling Apart Black Holes and Naked Singularities

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CAMK Annual Meeting

February 4, 2026

Two Investigations into Compact Objects

Preprints

1. Accretion Disk Signatures
    - Distinguishing Kerr Black Holes from Wormholes.
    - Focus: Kerr-like “mimickers”.
    - Observable: Surface temperature of the accretion disk.
        - Submitted to *PRD*, arXiv:2512.07466 with W. Kluzniak and M. Wielgus
2. Dynamics of Massive Particles
    - Distinguishing Black Holes from Naked Singularities.
    - Focus: Reissner-Nordström spacetime.
    - Application: Tidal Disruption Events (TDEs).
        - Submitted to *MNRAS*, arXiv:2509.24114 with W. Kluzniak

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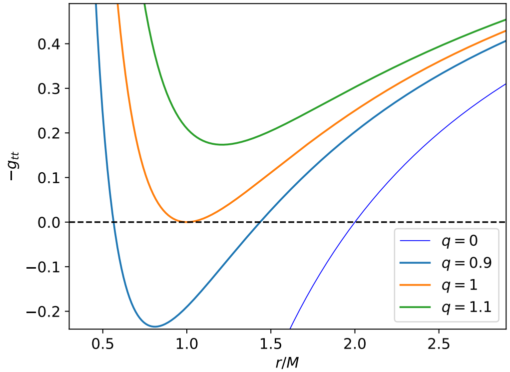
- Following in Einstein’s footsteps with THC and LSD, Prague CZ, December (talk in ASU)

Telling Apart Black Holes and Naked Singularities

Naked singularities are another possible final state of gravitational collapse.

- Contrary to naked singularities, in a black hole the singularity is enclosed by the event horizon.
  - $r_{\mathrm{h}} = M + \sqrt{M^2 - Q^2}$
- **Black Hole ($Q \leq M$):** Event Horizon exists.



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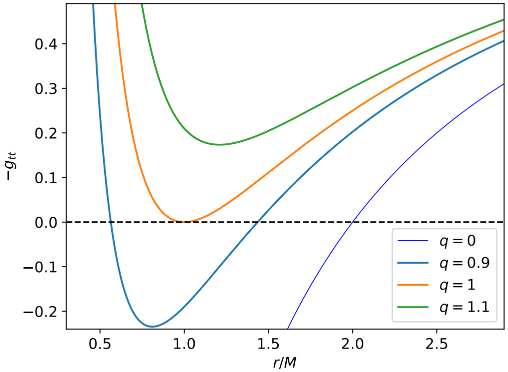
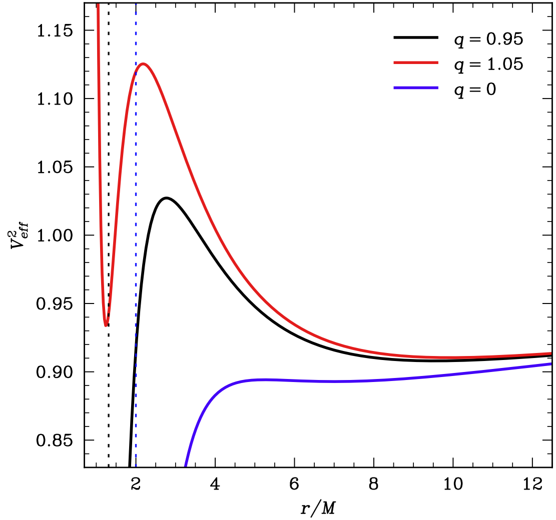
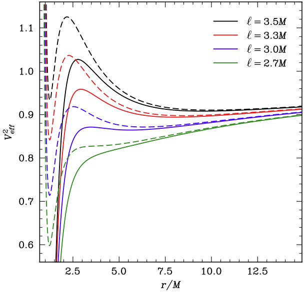
- Contrary to naked singularities, in a black hole the singularity is enclosed by the event horizon.
  - $r_{\mathrm{h}} = M + \sqrt{M^2 - Q^2}$
- **Black Hole ($Q \leq M$):** Event Horizon exists.
- **Naked Singularity ($Q > M$):** No Event Horizon. Singularity exposed.



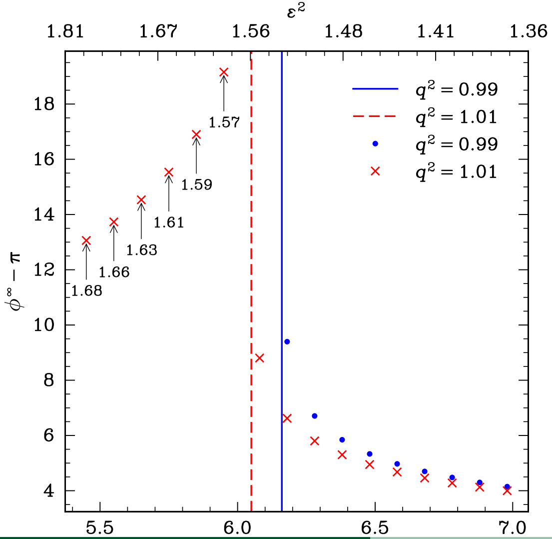
The Effective Potential

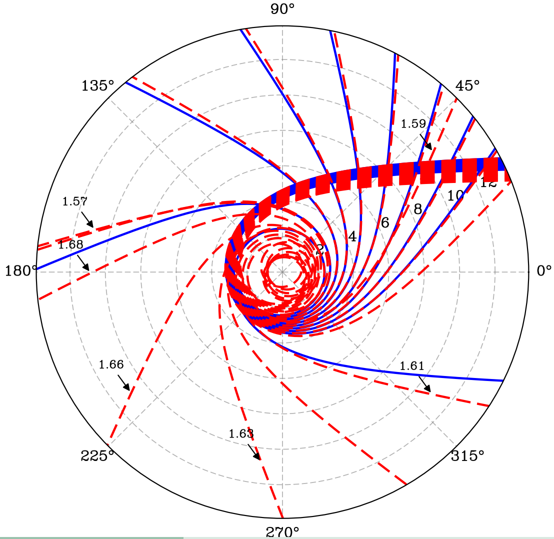


- **Black Hole:** Centrifugal barrier exists, Particles crossing the barrier are **captured** by the horizon.
- **RN Naked Singularity:** Repulsive core near $r = 0.$, Particles are **reflected** by the repulsive core when they cross the centrifugal barrier.

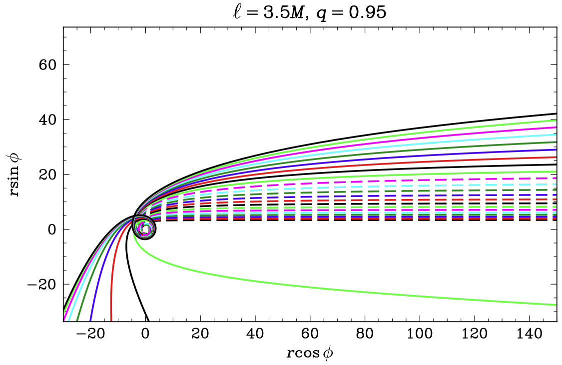


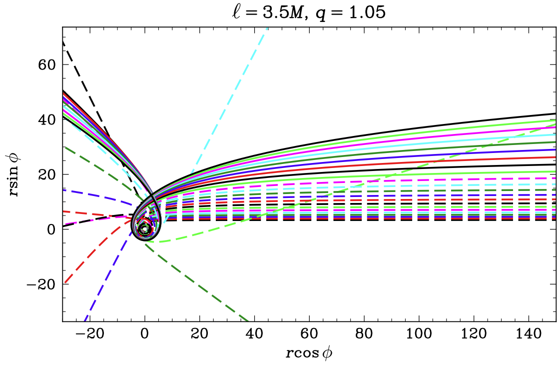
Nearly external charge



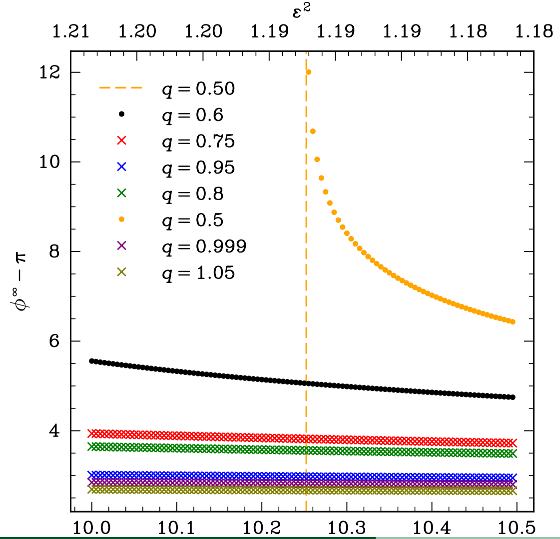


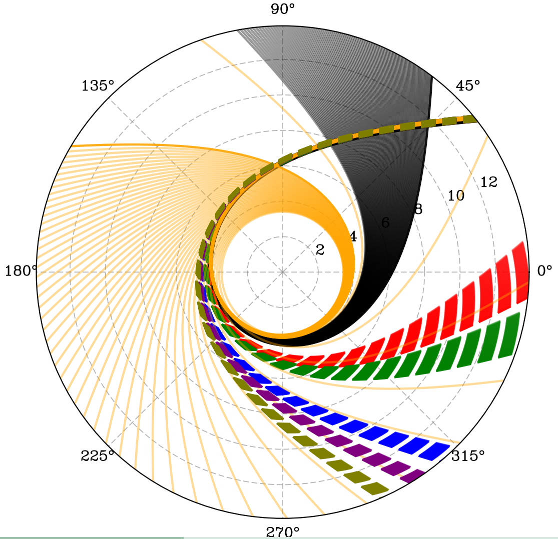
Trajectories (wide incoming stream)





Narrow stream deflection





Conclusions

We investigated the differences in the orbital dynamics of massive particles around black holes (BHs) and naked singularities (NkSs) in the Reissner-Nordström geometry. We found that for a (wide) infalling stream of particles after being reflected by a BH follow a stream-like family of orbits within a narrow range of deflection angles, whereas in case of NkSs particles are scattered in all directions on the plane of motion.

Building upon the previous analysis, we outline a framework for dynamically distinguishing between black holes and naked singularities or set constrains to charge-to-mass ratio based on the observed characteristics of scattered TDE streams.