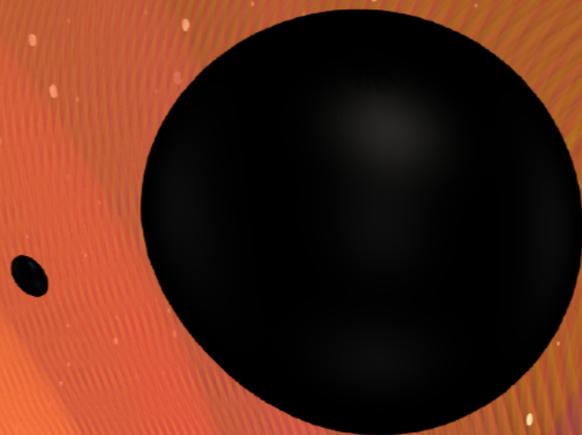


# Panel discussion: Numerical Relativity Perspective

Advances in Computational Relativity  
ICERM, Oct 9, 2020



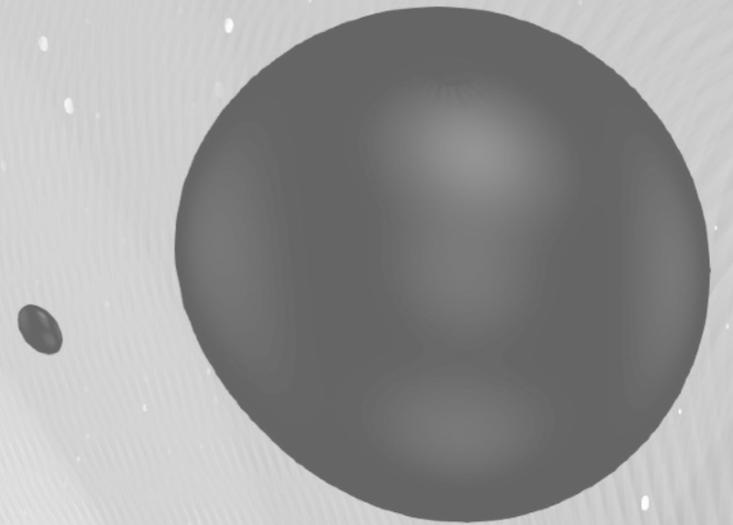
**Harald Pfeiffer**

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# Exciting challenges

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- **Future GW detectors; GW inspirals that pass from LISA  $\rightarrow$  {ET, CE}**
  - broader bandwidth, higher accuracy, more diverse sources
  - current robust reach of NR:  $q \gtrsim 1/10$ ,  $S/M^2 \lesssim 0.9$ ,  $N_{\text{orbits}} \sim 20$  (with trade-offs between)
  - Needs to be expanded!!
- **Higher mass-ratios — more cycles, more fun!**
  - higher measurement accuracy  $\propto 1/N_{\text{orbits}}$
  - more time for interesting dynamics (transitional precession, eccentricity, resonances)
  - stress-test PN, bridge mass-ratio NR  $\leftrightarrow$  SMR
- **Exquisitely accurate simulations**
  - need to control numerics, BCs, numerical viscosity, GW extraction
  - constrain modified gravity through best possible null-tests
- **Next generation of NR codes**
  - Zach Etienne: BBH on a *phone*
  - SpECTRE — C++17 & task-based parallelism so refreshingly different
- **Astrophysical environments:**
  - Apparent violation of GR = insights into the astrophysical environment of the source?
- ~~Exciting~~ **tedious but *really* important: cross-code comparisons for generic BBH**
  - precession, eccentricity
  - essential for trust in waveforms that underpin GW parameter estimation and tests of GR



# New directions @ analytical-numerical interface

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- **novel numerical schemes**
  - worldtube excision
  - implicit time-stepping
  - truly reach scri+: cauchy characteristic matching / hyperboloidal slicing
- **non-perturbative higher order theories of gravity**
- **novel behavior at nearly extremal spins (?)**
  - $S/M^2 = 0.99, 0.9999, 0.999999 ?$
- **analytical-NR comparisons beyond quasi-circular**
  - BH scattering / eccentric / high-q / zoom whirl
    - probe different sectors of analytical schemes
    - validation for NR simulations
- **More “mundane” problems that aren’t completely understood**
  - definition of BH spin in NR
  - existence of marginally trapped surfaces
- **.. and some more topics that came up in this workshop**
  - Properties of singularities
  - boundary conditions & GW extraction in de-Sitter (as in our universe!) or AdS (for AdS-CFT)

