LISA science at LUTH

Laboratoire Univers et THéories

- Laboratory of Paris Observatory since 2001.
- Around 30 permanent researchers (CNRS, CNAP and Universities)
- **Field of activity** : theory and modelisation of astrophysical objects.

Four teams

- Cosmology (*)
- High energy physics (*)
- Multi-scale astrophysics
- Relativity and compact objects (*)

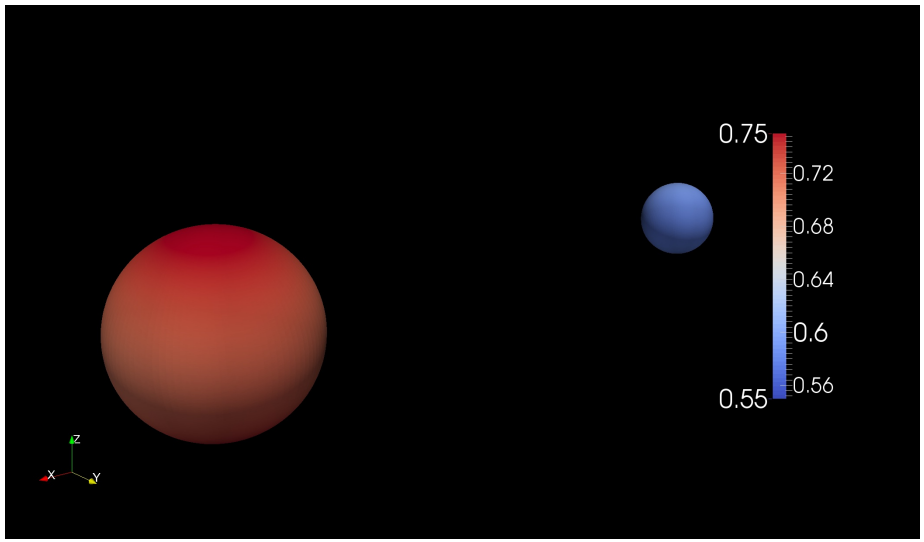
Involvement in LISA

LUTH is concerned with the study of the sources

- Member of LISA-France since its creation.
- Not directly involved in data processing.
- No GW explicitly produced (yet).
- But studies of compact objects and situations with strong gravity.
- P.G. co-organizer of the "Test of fundamental laws" working group (but few activities so far).

Binary Black holes computations

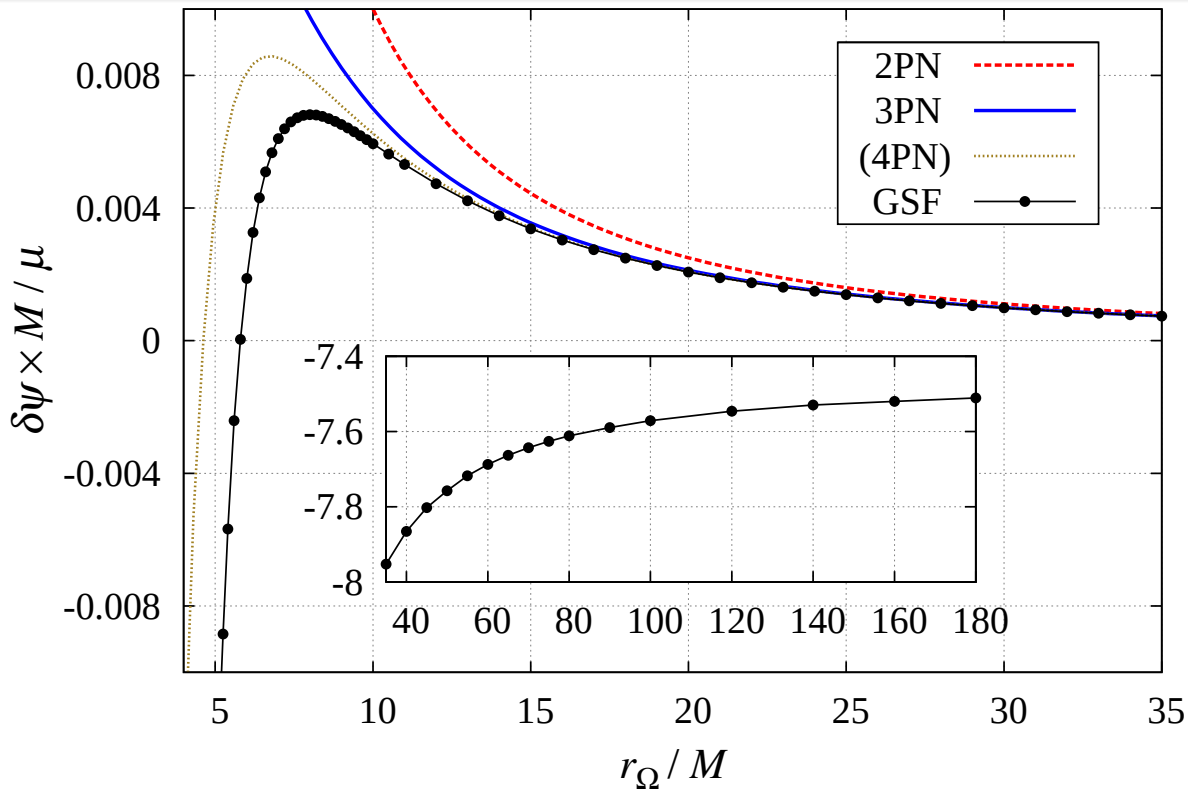
- No time evolution (yet)
- Quasi-circular orbits (time-independent problem)
- So far conformally flat approximation.
- Numerical solutions (spectral methods).
- Useful as initial data.
- Calibration of analytic waveforms (EOB for instance).



Analytic developments

Various approaches

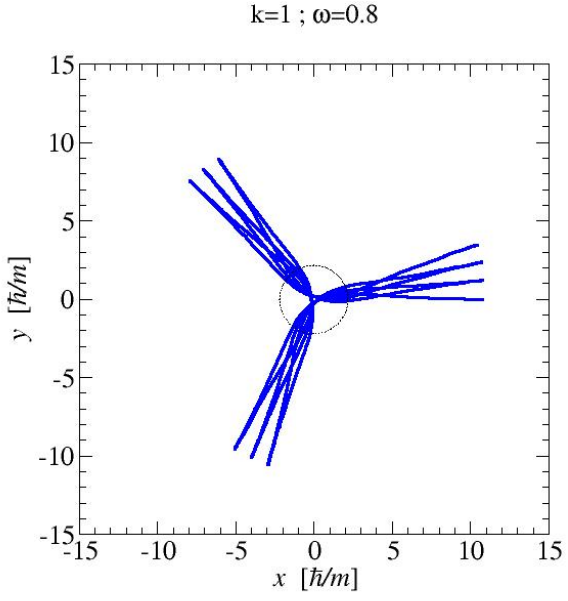
- PN expansions.
- Perturbation theory.
- Self-force computations (EMRIs)

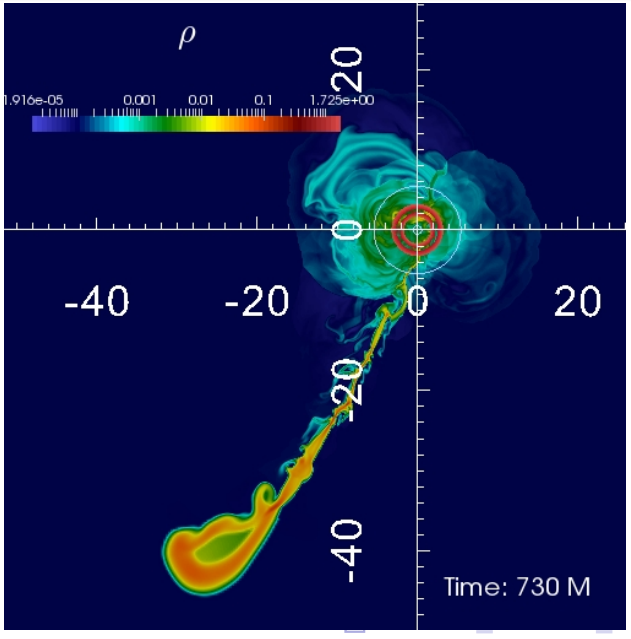


Alternative models to black holes

Example : boson stars

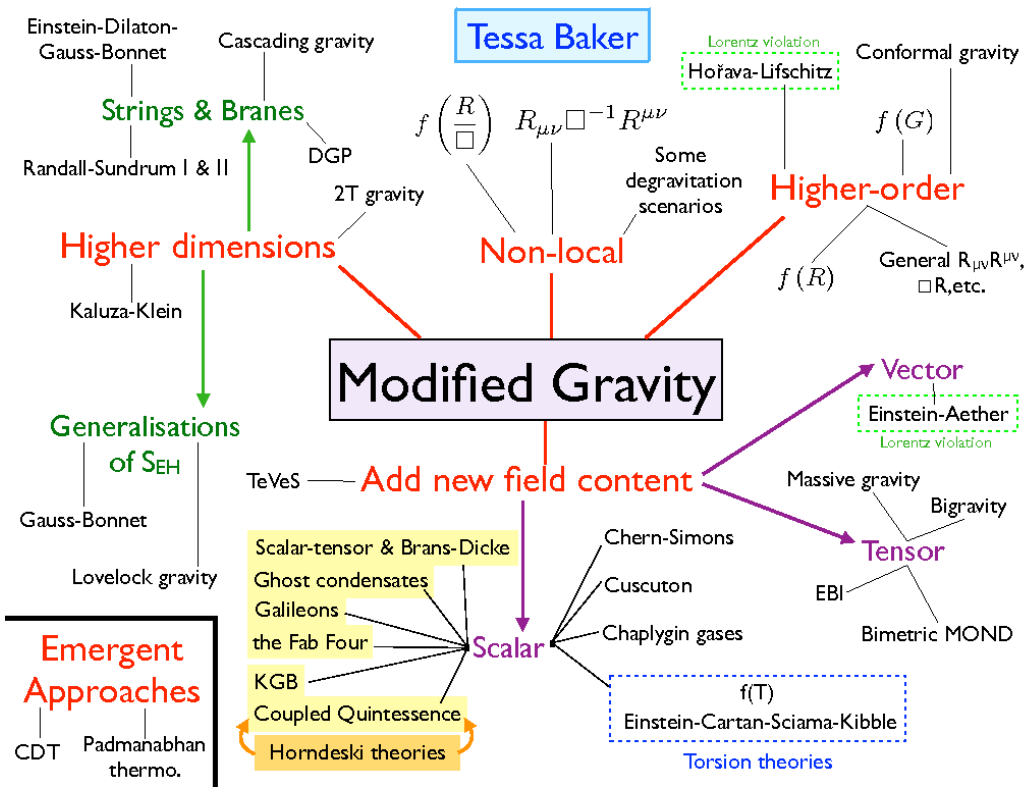
- Scalar field coupled to gravity.
- Can reach very high compactness without an event horizon.
- Can mimic supermassive black holes.
- Existence of very specific geodesics.
- Influence on the GW signal from EMRIs ?
- Dynamic of infalling gas cloud also different.





Beyond standard GR

- Compute models of stationary and axisymmetric BH in various theories of gravity.
- Examples : Horndeski theory or Chern-Simons gravity.
- Compute the quasi-normal modes and see the differences with Kerr.



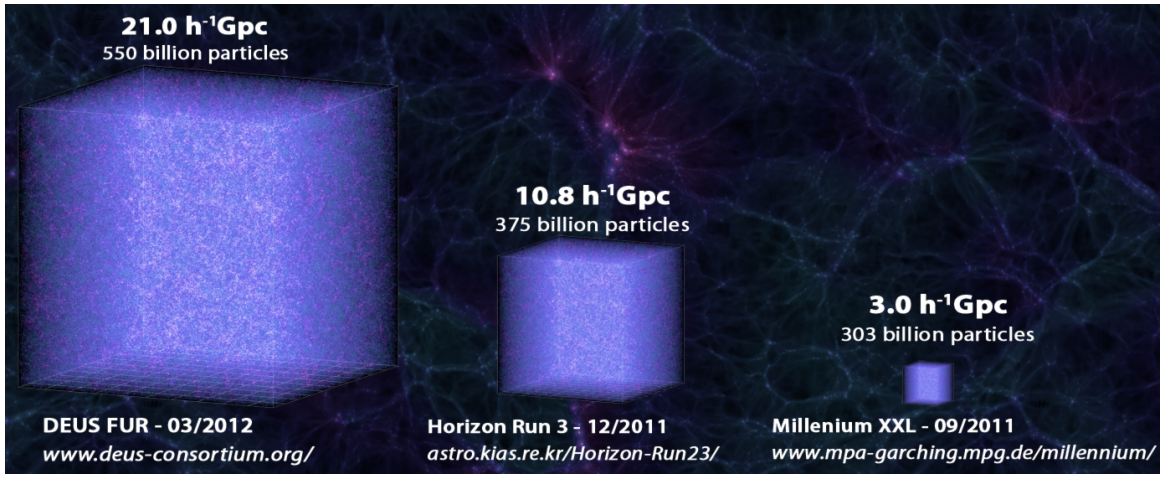
Cosmology

Expertise at LUTH

- High performance N-body cosmological simulations.
- Influence of dark matter on structure formation.

Link with LISA

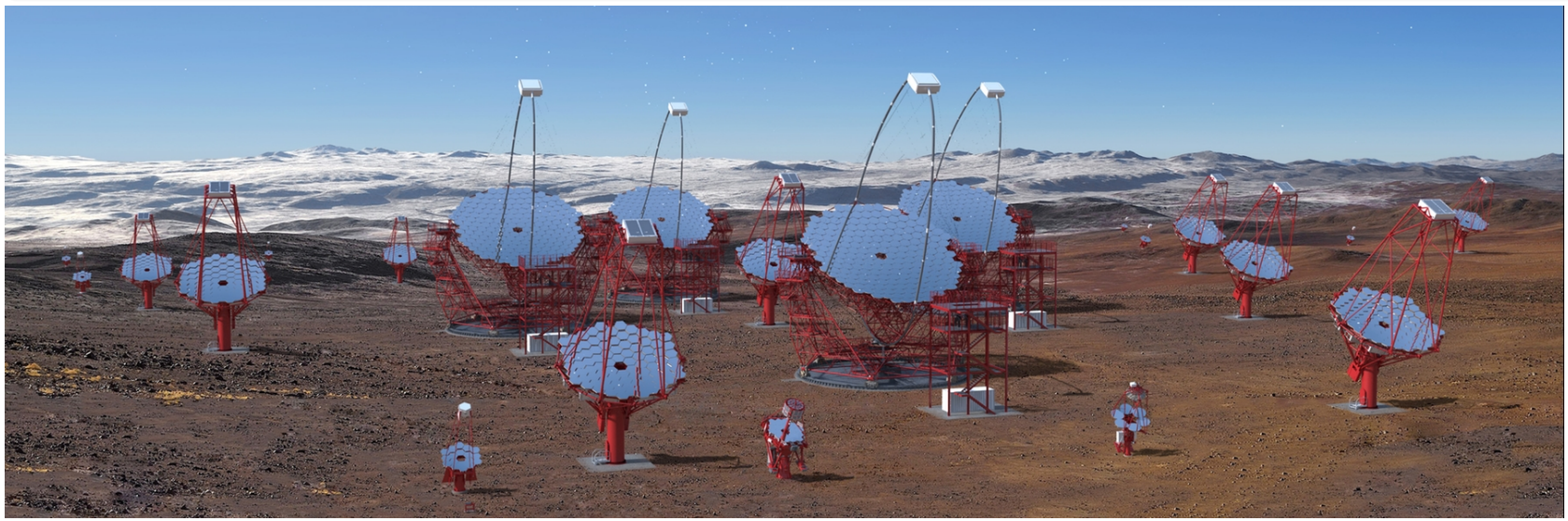
- Galaxy formation linked with SMBBH mergers.
- LISA will trace the history of the growth of galaxies.



High energy team

Multi-messenger astronomy

- LUTH involved in Cherenkov telescopes HESS and future CTA.
- Implication in EM counterparts search to GW events.
- Effort should continue in the LISA era.



The future...

- Probably not involved directly in the data processing.
- Study of the **sources** of GW.
- Give some information about the concerned compact objects (structure, properties...)
- Try to make the link with the emitted GW more explicit in the forthcoming years.
- Involved in the multi-messenger astronomy.