VLBI signatures of ultracompact boson stars

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In 2019, the Event Horizon Telescope (EHT) collaboration released the first image of the supermassive black hole (SMBH) in the galaxy M87 [1]. The image shows a bright ring of light surrounding a dark region, which is consistent with the predictions of General Relativity (GR). Since then, a similar image of the SMBH in the center of our own galaxy, Sagittarius A*, has been released [2].

Theoretical physicists believe, however, that the black holes we observe in the sky cannot be the black holes of GR: the latter come with theoretical problems, such as the existence of a singularity at the center of the black hole, and the information paradox. Therefore, physicists have been developing models for "black hole mimickers", objects that appear like black holes in observations, but are fundamentally different. One such family of models are boson stars; self-gravitating configurations of a very light complex scalar field [3]. In recent work in our group we have investigated the dynamical stability of ultracompact boson stars: ultracompact here means that the boson star spacetime features (a pair of) light rings - circular trajectories that light can follow without ever escaping. Such light rings are of great interest in the context of the EHT images, as their presence gives rise to the so-called photon rings; highly lensed images of the accreting matter around a black hole which can be used to test GR and the black hole paradigm [4].

These photon rings are known to have strong imprints on the VLBI measurements [5], such as made by the EHT. In this project, we will further explore the differences in the VLBI measurements between ultracompact boson stars and black holes, and investigate whether these differences can be used to distinguish between the two in future EHT observations.

References

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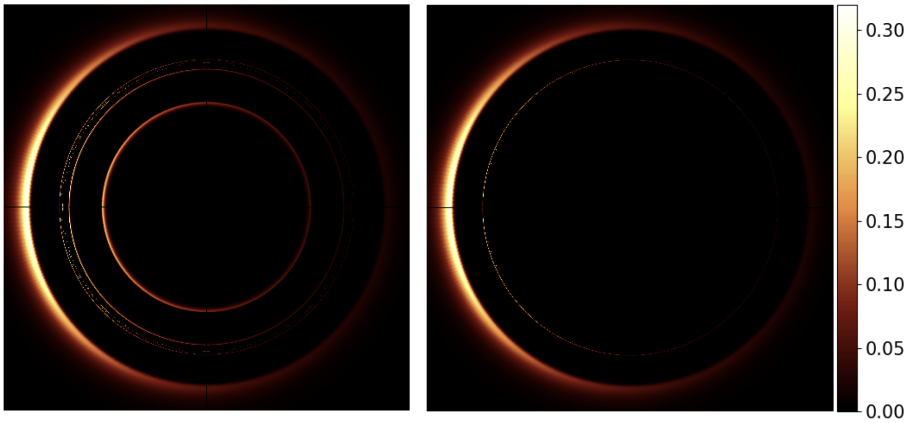

Figure 1: Side-by-side comparison of ray-traced images of the (*left*) boson star and (*right*) black hole of the same mass. The colour scale indicates the observed brightness intensity, in arbitary units, from a simple geometrically thin disk located in the equatorial plane. Images obtained with FOORT

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