THE FIRST SUPER MASSIVE BLACK HOLES

COMPARING MODELS WITH OBSERVATIONS

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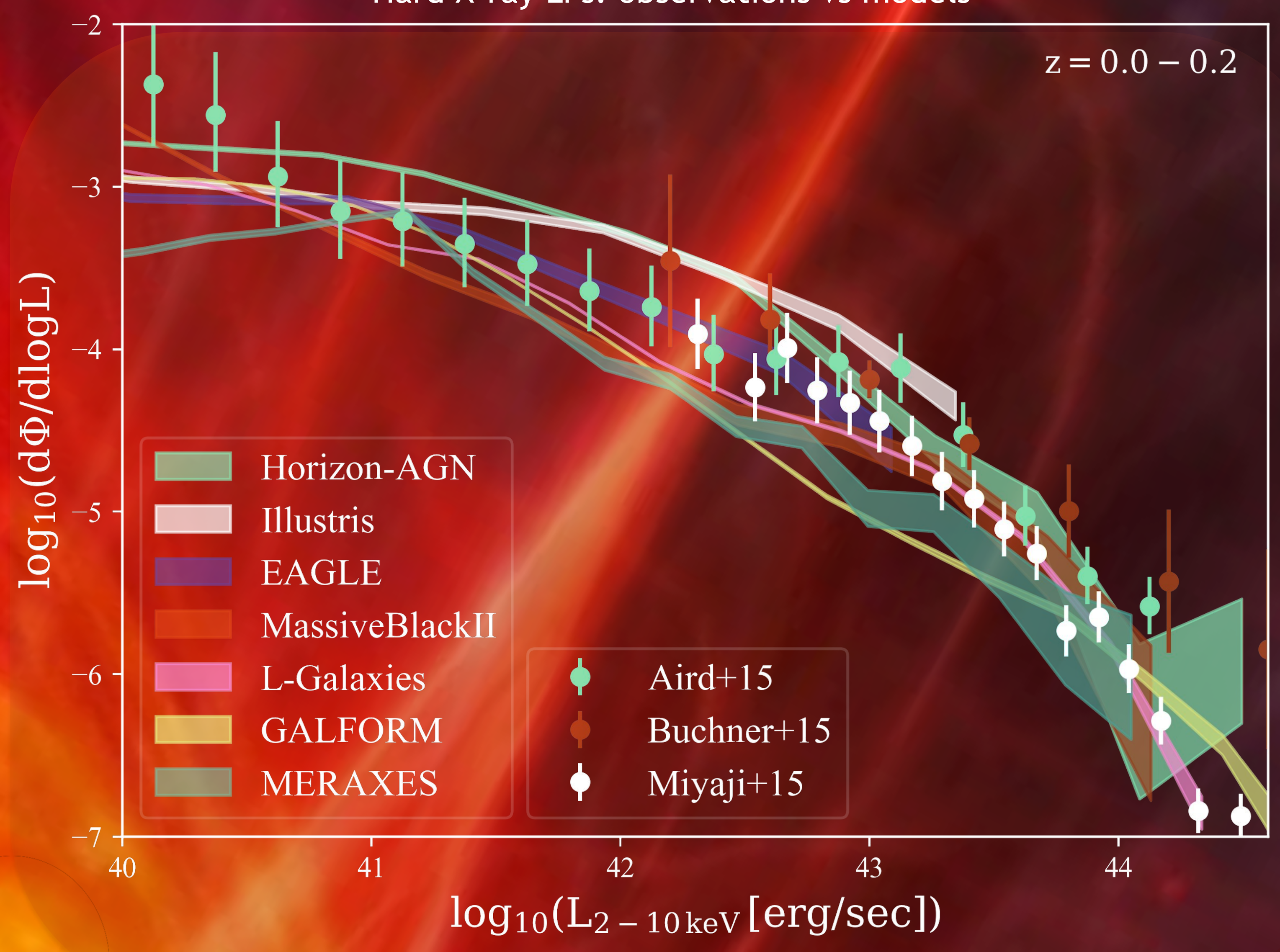
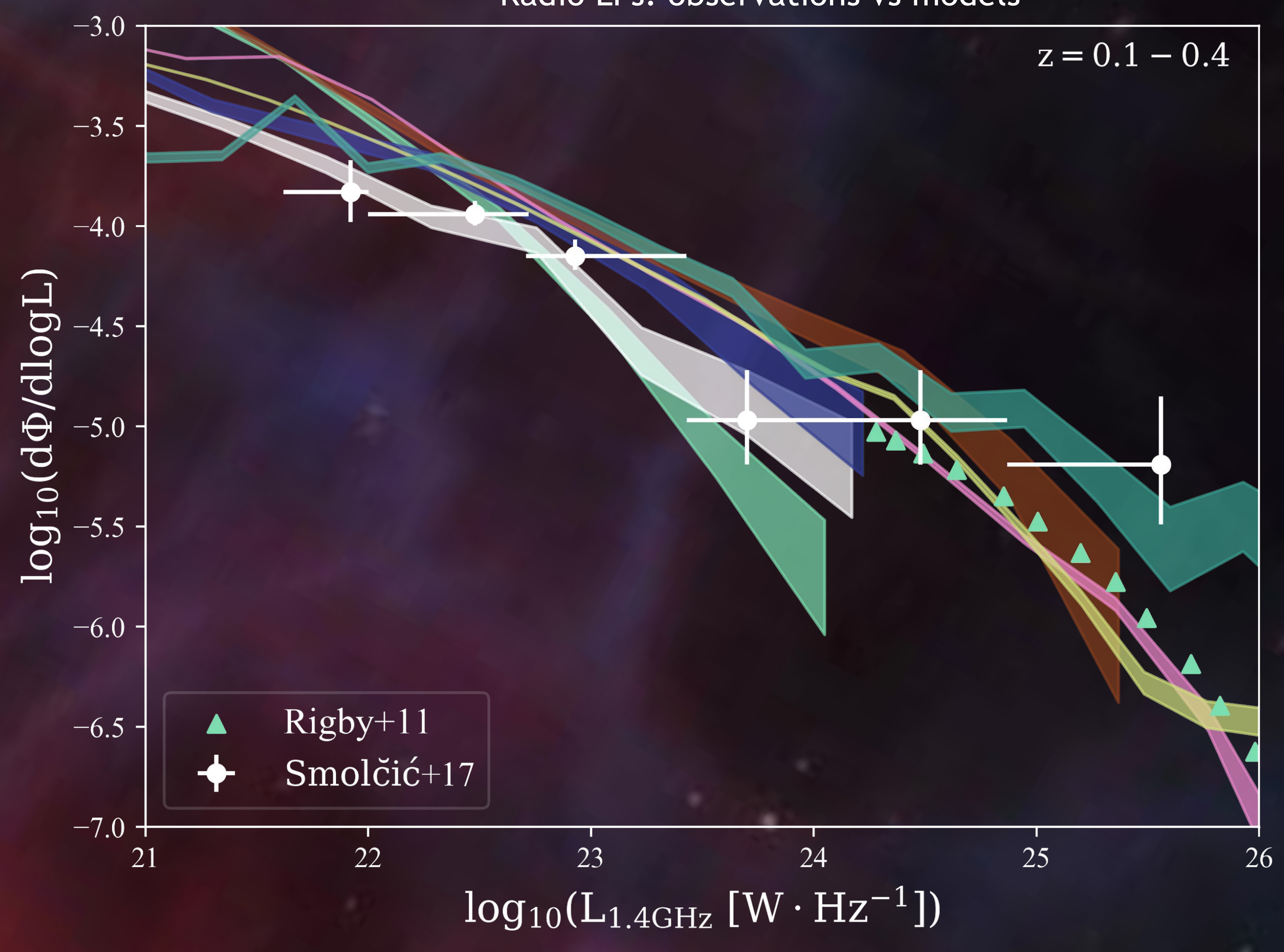
We present an exploration of state-of-art galaxy formation and evolution semi-analytic models and hydrodynamical simulations for the prediction of the detection of the earliest AGN in the Universe. To assess this, we estimate the number and radiative characteristics of Super Massive Black Holes (SMBHs) at z ≥ 6, a redshift range that will be intensively explored by the next generation of telescopes, in particular in the radio through the Square Kilometre Array (SKA) and at high energies with ESA's Athena X-ray Observatory. With this study we aim not only to obtain estimates for the AGN population at high redshifts, which can allow modifications in the observing strategy of the next generation of telescopes, but modifications and improvements of the models as well. In this sense we stress the importance of the Volume of the simulation box as well the initial physical conditions, on their effect on the luminosity functions (LFs) and the creation of the most massive SMBHs that we currently observe at high redshift. The following plots depict the hard X-ray (2-10 keV) and radio (1.4 GHz) LFs from the models/simulations at low redshift and their comparison with observational data.

Hard X-ray LFs: observations vs models



Radio LFs: observations vs models



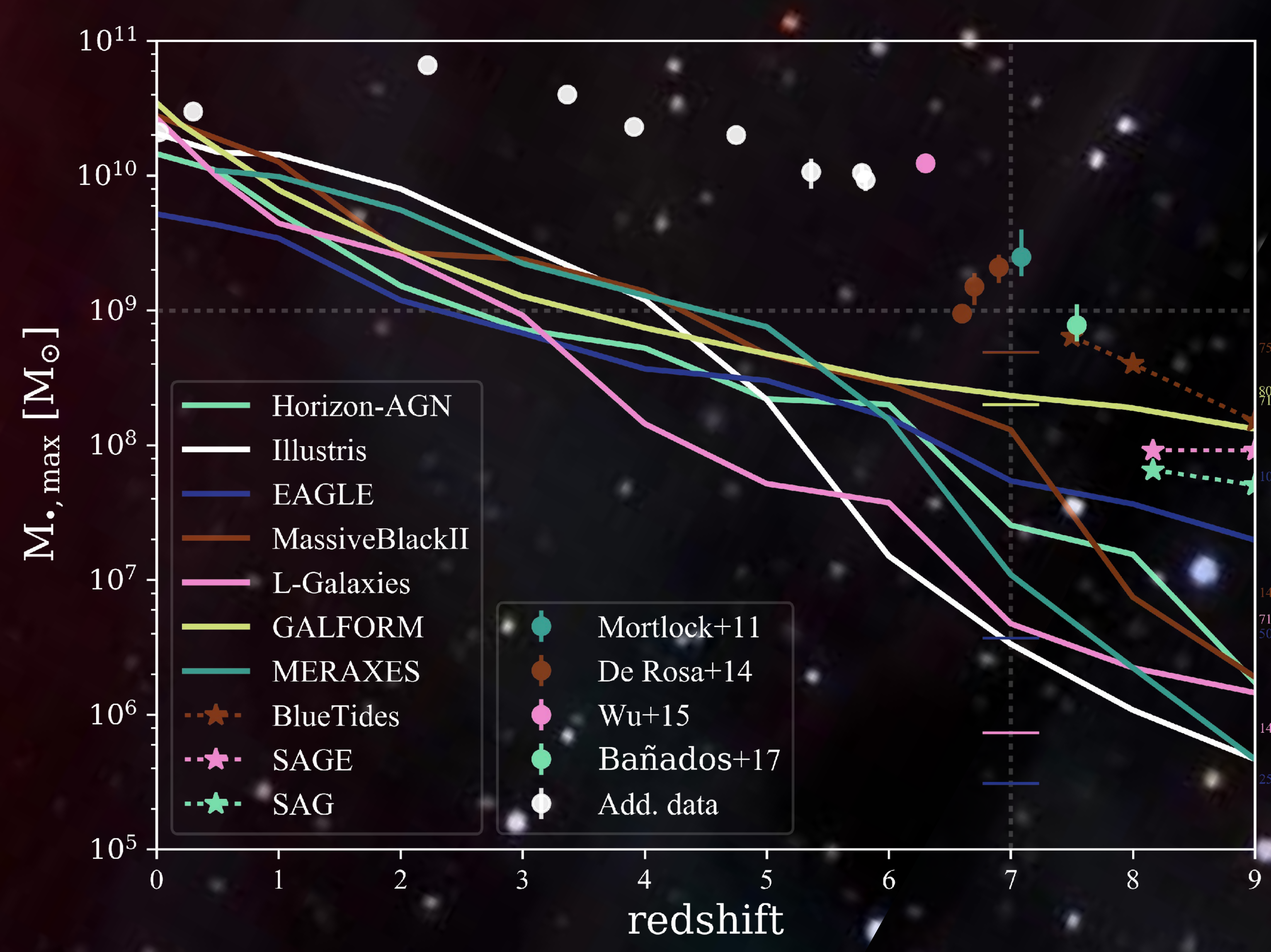
Following these results we derive the LFs for the Epoch of Re-ionization (EOR - z ≥ 6) and estimate the number of AGNs at these redshifts. The models match the observed Luminosity Functions (LF) for the well-known low redshift (z) AGN population and show interesting predictions for the not well studied high z regime. For the first time we are able to present the SMBH/AGN population at the Epoch of Reionization (z=8-10, corresponding to an age of the Universe of 0.5 Gyr) and predict that for a survey covering 1000 square degrees:

Athena ⟶ 514000 AGN SKA ⟶ 28000 AGN

All the results presented here have been published in Amarantidis et al. (2019) where the reader can find further details about the analysis.

Additionally we show that there is a need for improvement in the models as they lack to re-create SMBH observables as the most luminous and massive AGN. This need can be seen in the right plot which depict the most massive SMBHs that each model can produce for various redshifts. As we can see none of the models can predict the most massive SMBHs that we observe for z ≥ 2 due to three possible reasons:

- Simulation Volume
- Initial conditions
- Super-Eddington accretion



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