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Tracing Massive Black Hole evolution with Gravitational Waves and dual AGN

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Understanding the formation and evolution of intermediate-mass (IMBH; $10^3 M_\odot < M_{\rm BH} < 10^5 M_\odot$) and supermassive black holes (SMBH; $M_{\rm BH}$ $10^5 M_\odot$) is among the hottest and most challenging open topics in astrophysics. The proposed Lunar Gravitational-wave Antenna (LGWA) will open a new observational window on the mergers of these systems, probing a frequency range complementary to existing (Laser Interferometer Gravitational-Wave Observatory, Virgo, KAGRA and Pulsar Timing Arrays [PTAs]) and planned (Laser Interferometer Space Antenna [LISA] and Einstein Telescope) gravitational-wave observatories. In this talk, I will present a simple framework to predict the population of IMBH binaries detectable by LGWA. Using dark matter-only cosmological simulations from PINOCCHIO code combined with the semi-analytical model PinGAEA, I will present a model to track the separation of MBH pairs starting from megaparsec scales of halo merger down to the galaxy merger and eventually the BH merger. Using this model on both light (~$100 M_\odot$) and heavy ($10^5 M_\odot$) BH seeding schemes, I will create populations of IMBHs and SMBHs pairs which will be used to make predictions for the dual AGN fraction and compare with the latest observational estimates. I will also present the merger rate of these MBH pairs detectable by LGWA and LISA. Finally, I will show the GW background generated by these MBH pairs, and compare with the latest results from PTA experiments.

Primary authors: SINGH, Jasbir (INAF - Osservatorio Astronomico di Brera); SEVERGNINI, Paola (INAF - Osservatorio Astronomico di Brera); CAMMELLI, Vieri (Università degli Studi di Modena e Reggio Emilia); DE ROSA, Alessandra (INAF – Istituto di Astrofisica e Planetologia Spaziali); VIGNALI, Cristian (Dipartimento di Fisica e Astronomia 'Augusto Righi', Università degli Studi di Bologna); VALIANTE, Rosa (INAF – Osservatorio Astronomico di Roma); AL., et

Presenter: SINGH, Jasbir (INAF - Osservatorio Astronomico di Brera)

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