XIV Serbian Conference on Spectral Line Shapes in Astrophysics
Bajina Bašta, Serbia, June 19 - 23, 2023
Book of Abstracts, Eds. Luka Č. Popović, Nataša Bon, Edi Bon and Sylvie Sahal-Bréchot

EMISSION LINE REGIONS IN ACTIVE GALAXIES: SELECTED STUDIES IN SPECTRAL LINE VARIABILITY IN THE ERA OF JWST AND LSST

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The study of the line-emitting regions in active galaxies (AGNs) has had a long and profound history - from the very first confirmation of the extragalactic origin of AGNs to reverberation mapping leading to the size determination of these regions, to now AGNs and quasars being used as "standardizable" cosmological candles to understand the evolution of our Universe. We have already entered the era of big telescopes, and with the early success of JWST and with the upcoming Vera C. Rubin Observatory's LSST, the future of exploration of AGNs across cosmic time is exciting. In this review, I will present some recent progress in AGN variability studies in preparation for the massive data surge with LSST. I will discuss some recent advancements from the AGN Polish Consortium side for the in-kind contribution to LSST. I will demonstrate how the research uses quasars for Cosmology and understand the nuances to calibrate them as standard candles, focusing primarily on the broad-line region size-luminosity relation and highlighting our recent advances to better understand this connection from various aspects - from spectroscopic studies to photoionization modeling to joint analyses with other cosmological probes. I will briefly review selected studies and how the combination of theoretical insights and advancements in telescope capabilities have allowed us to gain further insights into these captivating cosmic systems.