Preprint Series in Particles and Cosmos Physics

nº IPARCOS-UCM-24-017

INSTITUTO DE FÍSICA
DE PARTÍCULAS Y DEL COSMOS

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Atacama Large Aperture Submillimeter Telescope (AtLAST) Science: Surveying the distant Universe

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March 2024

Plaza de las Ciencias, 1 28040 Madrid, Spain

www.ucm.es/iparcos/

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Abstract

During the most active period of star formation in galaxies, which occurs in the redshift range 1<z<3, strong bursts of star formation result in significant quantities of dust, which obscures new stars being formed as their UV/optical light is absorbed and then re-emitted in the infrared, which redshifts into the mm/sub-mm bands for these early times. To get a complete picture of the high-z galaxy population, we need to survey a large patch of the sky in the sub-mm with sufficient angular resolution to resolve all galaxies, but we also need the depth to fully sample their cosmic evolution, and therefore obtain their redshifts using direct mm spectroscopy with a very wide frequency coverage. This requires a large single-dish sub-mm telescope with fast mapping speeds at high sensitivity and angular resolution, a large bandwidth with good spectral resolution and multiplex spectroscopic capabilities. The proposed 50-m Atacama Large Aperture Submillimeter Telescope (AtLAST) will deliver these specifications. We discuss how AtLAST allows us to study the whole population of high-z galaxies, including the dusty star-forming ones which can only be detected and studied in the sub-mm, and obtain a wealth of information for each of these up to z~7: gas content, cooling budget, star formation rate, dust mass, and dust temperature. We present worked examples of surveys that AtLAST can perform, both deep and wide, and also focused on galaxies in proto-clusters. In addition we show how such surveys with AtLAST can measure the growth rate and the Hubble constant with high accuracy, and demonstrate the power of the line-intensity mapping method in the mm/sub-mm wavebands to constrain the cosmic expansion history at high redshifts, as good examples of what can uniquely be done by AtLAST in this research field.

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