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Sustaining Submillimeter Science: New Development

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1 ALMA Now and in the Nexr Decade

Vigorous and transformative investigation of the millimeter/submillimeter sky at high sensitivity and high resolution has benefitted from the recent completion of the Atacama Large Millimeter/submillimeter Array (ALMA)[1], an effort of 22 countries. ALMA, a versatile interferometric telescope at 5000m elevation in the Atacama Desert of northern Chile, is comprised of sixty-six precision telescopes which may be arrayed over a 16 km extent on the high Chajnantor plain[1]. Owing to its large collecting area of over 6600m^2 and its commodious spectral grasp of 8 GHz of spectrum in dual polarizations within an 84-950 GHz range, ALMA provides astronomers with vastly improved spectroscopic sensitivity. Spatial resolutions of 20 milliarcsec were demonstrated recently, revealing a 1AU dark annulus in the TW Hya disk[2]. Using ALMA's excellent imaging quality, dark substructure was found in the galaxy gravitationally lensing SDP.81[3]. The ALMA system is dynamically upgraded–very long baseline capability is expected to bring microarcsecond imaging to a worldwide array anchored by ALMA with excellent potential for imaging nearby Black Holes on the scales of their Event Horizons.

During the upcoming decade through 2030, new capabilities will expand ALMA's envelope of exploration even further. Completing its 35-950 GHz spectral grasp, ALMA's final receiver bands will be deployed. Band 5 (163-211 GHz) has been offered for science beginning March 2018; receiver construction has begun for Band 1 (35-51 GHz) and a prototype has been constructed and tested for Band 2^+ (67-95 GHz).

ALMA has delivered over 1,000 datasets that have resulted in over 570 refereed publications that have garnered over 5000 citations. The ALMA Development Program sustains the pace of ALMA science through community-led studies and implementations of improvements to ALMA hardware, software, and techniques. Building on the successes of the initial suite of capabilities, ALMA seeks to enhance its initial capabilities in several key areas leading to the 2030 decade. These include increased bandwidth (for increased sensitivity and spectral coverage), increased imaging speed (cameras / focal plane arrays), and higher angular resolution (longer baselines). The scientific thrust will include the ability for enhanced imaging of planetary disks, galaxy assembly, and chemical analyses of star-forming regions. An upgraded correlator is under study, which will enlarge the number of channels and increase resolution by 8x, while improving spectral sensitivity by employing more bits. When complemented with an upgraded digitization and frequency distribution system, also under study, the correlation capacity may be doubled to 8 GHz per polarization and sideband. Several ALMA receivers already present more bandwidth to the correlator than it can currently process; the Band 6 receiver, for example provides two 5 GHz sidebands in two polarizations. Other improvements are under way, (1) to the ALMA Archive: enabling gains in usability and impact for the observatory; (2) implementation of the longest baselines at the highest frequency, along with study of achieving longer baselines at lower frequency to match, and (3) increasing wide field imaging, to provide efficient wider area coverage. ALMA is developing a Vision for identifying the capabilities needed to address community science drivers for the coming decade, which will be discussed at the conference. NRAO expects to periodically issue a new Call for Proposals for Development Studies to enhance that Vision.

References

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[3] Hezaveh, Y. D., Dalal, N., Marrone, D. P., et al. 2016, ApJ, 823, 37

[1]ALMA is a partnership of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC (Canada), NSC and ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile. The Joint ALMA Observatory is operated by ESO, AUI/NRAO and NAOJ.