Contribution ID: **113** Contribution code: **CC04** Type: **Talk**

Observing radio transients with Phased ALMA

Tuesday, January 6, 2026 4:55 PM (15 minutes)

Radio transients, such as pulsars and fast radio bursts (FRBs), are primarily detected at centimetre (cm) radio wavelengths, where higher luminosities are found. However, could we study them at millimetre (mm) waves? For pulsars, this window remains poorly studied, but it represents a stepping stone to connecting the cm-radio emission with infrared/optical wavelengths and to discerning where the transition from coherent to incoherent emission occurs. For FRBs, detections have been made up to 8 GHz. Thus, studying radio-emitting neutron stars at millimetre wavelengths offers a direct link to FRBs and may indicate whether they can be detected above the classic cm- window.

In this presentation, we will explore new capabilities at ALMA that enable the observation of radio transients from 35 up to 300 GHz. The Phased ALMA Mode (PAM) was introduced in Cycle 8 (2021) to enable observations of weak radio sources (< 50 mJy), but only recently, in Cycle 11 (2024), it became available with its low-frequency instrument, Band 1 (35–50 GHz), with full polarisation. Importantly, when ALMA's 12-m antennas are coherently combined, they reach an equivalent sensitivity to an 80+ metre dish, enabling high-time resolution at mm-wavelengths with unparalleled sensitivity. We will present the results from the ongoing PAM campaigns, with a focus on our pilot study of the Galactic Centre magnetar, PSR J1745–2900. For this source, we detected a sample of highly polarised pulses at 86 GHz and used them to study the stability of the PAM system for transient searches, as well as the potential to detect bursts from repeating FRBs.

Due to its complex and scattered medium, the vicinity of Sgr A* holds the potential to serve as a laboratory for testing the behaviour of magnetars in extreme, magneto-turbulent environments and linking with FRBs.

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Session Classification: Contributed talks

Track Classification: CC04: Stars and Stellar Clusters