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Revealing local interstellar plasma structures through annual cycles of rapid scintillators

Abstract

Scintillation and scattering can be used to probe components of the interstellar medium that are to date poorly understood, yet may hold a significant fraction of the baryons in the Galaxy.
The recent, unexpected discovery of five intra-hour variable sources in a 2-degree long, straight linear arrangement, indicating a narrow plasma filament within 10 pc of the Sun, demonstrates that observations near 1 GHz with sensitive widefield imaging telescopes such as ASKAP and MeerKAT can be used to find and monitor rapid scintillators, to map out the local interstellar scattering plasma.
Regular monitoring of the scintillation over the course of a year is crucial to determine the kinematics and microstructure of the scattering plasma, using the changes in Earth's relative velocity as it orbits the Sun. Recent ASKAP observations have revealed that rapidly scintillating sources are often clustered in regions extending over several degrees of the sky, suggesting a possible common origin for the scattering "screens" toward each cluster. This proposal requests multi-epoch MeerKAT observations at L-band to determine the annual cycles for a ``cluster'' of intra-hour variable AGN, discovered in single-epoch ASKAP pilot survey observations. Annual cycles in the scintillation rate will be used to determine scattering screen velocity and position angle of anisotropy in the scintillation pattern, which will reveal any coherent structures in the scattering plasma and constrain plausible associations, e.g. with nearby stars or known local interstellar clouds.