

POLARIMETRIC ANALYSES OF ARCHIVAL ARECIBO NEAR-EARTH ASTEROID RADAR OBSERVATIONS. D.C. Hickson¹, A.K. Virkki¹, and E.G. Rivera-Valentín² ¹Arecibo Observatory-UCF, Arecibo, PR (dylan.hickson@ucf.edu), ²Lunar and Planetary Institute, USRA, Houston, TX.

Introduction: Polarimetric radar observations provide constraints on planetary surface properties, in particular for near-Earth asteroids (NEAs), through analyses of the observed radar backscatter. For example, the circular polarization ratio, μ_C , parameterizes the relative backscatter power received in the same sense circular (SC) and opposite sense circular (OC) polarization as transmitted (both Arecibo Observatory (AO) and the Goldstone Solar System Radar transmit a circularly polarized signal). This metric is sensitive to surface properties such as particle abundance/morphology [1], composition (ice content) [2], and surface roughness [3]. [4] showed the correlation between μ_C and taxonomic classification for NEAs, a result that has since been confirmed and strengthened [5]. However, the underlying physical properties reflected in this relationship are not well understood.

The linearly polarized component of planetary radar echoes has been shown to be sensitive to subsurface scattering on Venus and the Moon [6]. More recently, a comprehensive methodology for full (linear and circular) polarimetric analysis of NEA radar observations presented in [7] shows that tighter constraints on surface physical properties can be derived from archival radar observations from AO.

In this work, we extend the analysis in [7] to a larger sample of archival NEA radar observations from AO. Specifically, we investigate if significant correlations exist, similar to that observed for μ_C by [4] in other polarimetric parameters to better understand what physical properties can be inferred from available radar observations.

Method: The methodology for polarimetric analysis of archival radar observations is given in [7]. In [4], μ_C for each NEA are reported from disk-integrated continuous wave spectral observations. In [7], the polarimetric analysis is given for delay-Doppler images. This is useful for analyzing scattering properties across the surface of an observed NEA, but makes comparison between different NEAs difficult.

Following [7], we convert 2-dimensional delay-Doppler images of the degree of linear polarization, circular polarization ratio, degree of polarization, and *m-chi* decomposition into 1-dimensional histograms. We fit these histograms with appropriate probability density functions to extract the statistical properties of the measured values for each parameter. These statistics are then used for inter-object quantitative

analysis and to search for existing correlations. By also analyzing μ_C , we can compare our methodology to the results from [4] to validate our approach.

The polarimetric analysis in [7] requires high signal-to-noise ratio (SNR) observations, which could result from NEAs with slow rotation periods, that were observed relatively close to Earth, or large NEAs. As part of this on-going effort, we are searching the planetary radar data archive at AO for suitably high SNR observations to allow polarimetric analysis.

Preliminary Results: At the time of writing, we do not yet have a large enough sample size to permit meaningful statistical analysis. In our presentation we plan to include all results to date for individual NEAs studied, as well as corresponding statistics. In this early stage, we will focus our efforts on radar-observed E-type NEAs, which exhibit peculiar radar-polarimetric properties. As an example of the results for an ideal (in terms of the quality of derived polarimetry) NEA, we reiterate the findings from [7] for NEA 1999 JM₈ in Figure 1.

Conclusion: The growing planetary radar data archive represents a vast reservoir for the analysis of NEA surface properties. Improving our ability to extract information from existing data has profound implications for understanding not only individual objects, but also the NEA population. Here we present preliminary results in extending polarimetric analyses of these archival observations. The results of [4,5] revealed that planetary radar observations of NEAs could be a useful tool in classifying asteroid taxonomies. Our work provides additional metrics to inform this classification, as well as constraints to understand the underlying physical properties responsible for the observed radar backscatter.

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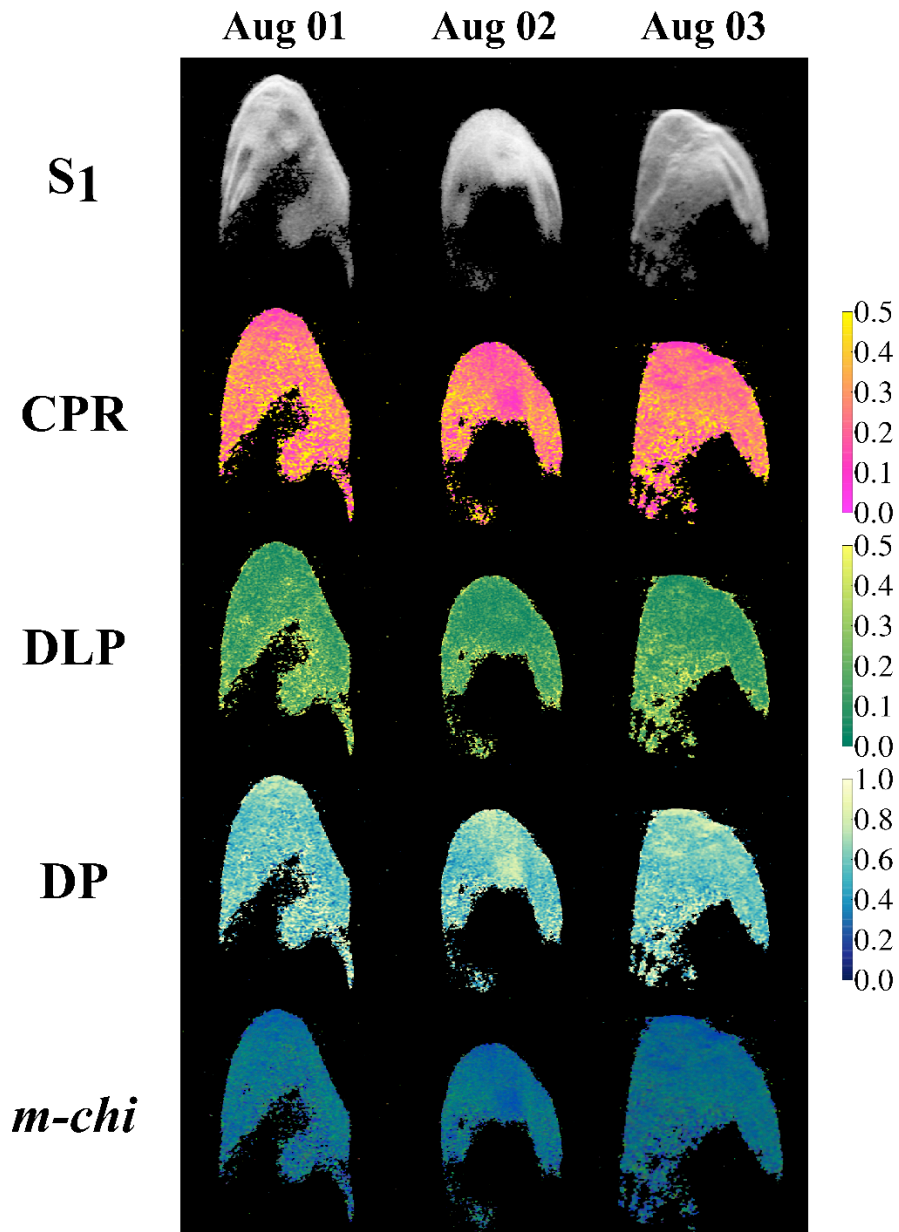


Figure 1: Polarimetric decomposition of NEA 1999 JM88 adapted from [7]. Results are for delay-Doppler observations obtained on August 1, 2, and 3 1999. S_1 is the first Stokes parameter, CPR is the circular polarization ratio, DLP is the degree of linear polarization, DP is the degree of polarization, and $m\text{-}chi$ is the $m\text{-}chi$ decomposition.