

## Faraday Rotation and Interferometric/Polarimetric SAR

Anthony Freeman, *Fellow*, IEEE  
Jet Propulsion Laboratory  
California Institute of Technology  
4800 Oak Grove Drive  
Pasadena, California 91109  
Tel: (818) 354 1887  
E-mail: tony.freeman@jpl.nasa.gov

*Abstract* – The potentially measurable effects of Faraday rotation on linearly polarized interferometric or polarimetric SAR measurements from space are addressed. Backscatter measurements subject to Faraday rotation are first modeled, and then the impacts are assessed using actual SAR data. Data characteristics found to be most sensitive to a small Faraday rotation (< 20 degrees) are the cross-pol backscatter [ $\sigma^{\circ}(\text{HV})$ ] and the like-to-cross-pol correlation [e.g.  $\rho(\text{HHHV}^*)$ ]. For a diverse, but representative, set of natural terrain the level of distortion across a range of backscatter measures is shown to be acceptable (i.e. minimal) for Faraday rotations of less than 5 degrees, and 3 degrees if the radiometric uncertainty in the HV backscatter is specified to be less than 0.5 dB.

Next a step-by-step procedure is outlined for correction (or calibration) of fully polarimetric data subject to Faraday rotation, to recover the true scattering matrix. The final steps in the procedure involve a novel strategy for estimation and correction of Faraday rotation. Sensitivity analyses are presented which show that at least one algorithm can be used to estimate  $\Omega$  to within  $\pm 3$  or 5 degrees, with reasonable levels of residual cross-talk, noise floor and channel amplitude and phase imbalance. This approach is relevant for future L-band spaceborne SARs and removes one key obstacle to the deployment of even longer wavelength SARs (e.g. a UHF or P-Band SAR) in Earth orbit.

The research described in this paper was carried out by the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

**Keywords:** Synthetic Aperture Radar (SAR), Polarimetry, Interferometry, Faraday rotation