# 8.4 DIFFERENTIAL PHASE UPON TRANSMISSION AS A NEW RADAR PARAMETER

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The main radar parameters are the wavelength, pulse repetition frequency, beamwidth, minimal detectable signal, and polarization configuration. These parameters are determined by the radar transmitter, receiver, antenna, and waveform of the radar pulse (e.g., pulse compression). The majority of polarization configurations are employed simultaneous transmission and reception of orthogonally polarized waves (STAR configuration). Typically, the differential phase between the transmitted waves is not controlled in STAR radars. The total system differential phase is the sum of the differential phases upon transmission and reception and is measured as a differential phase in the closest to radar edge of a radar echo.

It is shown that differential reflectivity ($Z_{DR}$), the differential phase ($\phi_{DP}$), and correlation coefficient ($\rho_{HV}$) measured with STAR radars depend not only on the size, shape, and orientation of scatterers, but on the radar differential phase upon transmission as well. This is illustrated on data collected with two radars having different differential phases upon transmission ($\phi_t$). Some "paradoxes" in radar data such as decreasing $\phi_{DP}$ values in areas of increasing $Z_{DR}$, the increase of $\phi_{DP}$ values with the antenna elevation angle, and different $\phi_{DP}$ range profiles measured with different radars are demonstrated and explained by the difference in $\phi_t$. It is shown that a variable t allows obtaining new information about scattering media such as the shapes and axis ratios of ice cloud particles and the parameters of hailstones. These opportunities make the $\phi_t$ a new radar parameter.

Possible implementations of the variable $\phi_t$ with STAR weather radars having dish antennas and phased array antennas are discussed. It is shown that the variable $\phi_t$ in phased array radar allows obtaining the full set of elements of the scattering matrix.