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Evidence for magnetospheric effects on the polarized radiation of pulsars

It is known that the radio signals of pulsars are highly linearly polarized, with the position angle (PA) of many pulsars changing across rotational phase in a way which is well described by the Rotating Vector Model (RVM). When the pulsar radiation propagates through the magnetized interstellar medium, it is affected by Faraday rotation. This results in a rotation of the plane of linear polarization as a function of observing wavelength, with a constant of proportionality known as the Rotation Measure (RM). If Faraday rotation is the only source of frequency dependence of the PA, we expect the derived RM to be independent of the rotational phase of the pulsar. However, for a small number of pulsars it has been observed that the phase-resolved RM varied, due to additional frequency dependencies affecting observed polarization. Until now, these additional frequency dependencies have been attributed to interstellar scattering. We have conducted the largest investigation to date into the origin of the frequency dependencies of polarized signals in radio pulsars, and showed that internal effects caused by the pulsar magnetosphere can play an important role as well, and sometimes even dominate.

Furthermore, we observe a clear correlation between the complexity of pulse shapes and the degree of RM variability, something inconsistent with an interstellar origin of the polarization variability. It is likely that, given sufficient signal-to-noise, such effects will be present in all radio pulsars. Our results imply that the frequency dependence of polarization gives a new way to probe the complex processes operating in pulsar magnetospheres.

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