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Complex polarisation variability in radio pulsars and the implication for pulsar magnetospheres

Pulsar polarisation is key to understanding the emission mechanism. Some radio pulsars exhibit puzzling polarisation properties and variability at the single-pulse level. PSR B0031-07 is one such radio pulsar, which shows rapid changes in position angle that are apparently modulated as the star rotates, and periodical changes are seen from pulse to pulse. It is demonstrated that this variability is linked to periodic pulse shape changes seen in total intensity. We show that the complex position angle variability can be explained by the presence of two coupled orthogonal polarisation modes (OPMs) that are attenuated as they propagate through the magnetosphere. This model is applied to as-yet unpublished data for B0031-07, which will be discussed in detail in the talk. This provides a way to reconcile the issue of asymmetrical pulse profiles and pulse shape variability with the predictions of the well-established carousel model, the often-invoked model to explain the origins of the radio emission of pulsars. By interpreting the variability as arising from these carousels of “sparks” circulating around the magnetic axis, the polar emission region can then be mapped. Understanding the structure and location of the emission region is fundamental in understanding the radio pulsar radiation processes.

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