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X/γ Ray Polarimetry of the Crab pulsar/nebula Observed by POLAR and IXPE

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The X/γ ray polarization properties of the Crab pulsar and nebula are widely recognized as a unique probe into their emission models. Several missions have shown evidence of polarized emission from the Crab but all have been limited in statistics. Dedicated instruments and new measurements are therefore required.
POLAR was a wide field of view Compton-scattering polarimeter (50-500 keV), which took data from September 2016 to April 2017 onboard the Chinese spacelab Tiangong-2. A novel polarimetric analysis method for the Crab pulsar observed by POLAR was recently developed. When applied to the Crab pulsar the method found that: 1) averaged phase interval, Polarization Degree (PD)=14^{+15}_{-10}\%, Polarization Angle (PA)=$108^{+33\circ}_{-54}$; 2) Peak 1, PD=17^{+18}_{-12}\%, PA=$174^{+39\circ}_{-36}$; 3) Peak 2, PD=16^{+16}_{-11}\%, PA=$78^{+39\circ}_{-30}$. To illustrate the capabilities of this method, a two-year observation of the Crab pulsar with POLAR-2 (the successor of POLAR) has been simulated. The simulation shows that POLAR-2 will be able to confirm the emission to be polarized with 5σ or 4σ confidence level if the Crab pulsar is polarized at 20% or 10% respectively.
The Imaging X-ray Polarimetry Explorer (IXPE) is a focusing Photoelectron-track polarimeters (2-10 keV). It is exploring the jet-torus morphology of the Crab nebula and the phase-resolved polarimetry of the Crab pulsar with unprecedented precision. Such results will put more stringent constrains on the models. In this talk, we will study the IXPE measurements of the Crab pulsar/nebula and compare it with that of POLAR and of other instruments at different energies. Based on that, we will also discuss the future prospects of multiple missions for the polarimetry of the Crab pulsar/nebula.

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