Contribution ID: **181** Type: **Talk**

The role of general relativity and reconnection in pulsar radiation

Tuesday, December 15, 2015 2:42 PM (20 minutes)

Pulsars shine throughout the electromagnetic spectrum, from radio waves to energetic gamma rays. The radio emission is thought to originate from the discharge of the polar-cap and the formation of copious electron-positron pairs. Gamma rays are traditionally associated with particle acceleration in electrostatic gaps within the light cylinder. The recent development of global Particle-In-Cell (PIC) simulations of the pulsar magnetosphere enables to test these scenarios self-consistently. We show that general relativistic effects, most notably frame-dragging, are essential to ignite pair creation in the polar cap for low-inclination pulsars, and hence enable pulsars to emit radio waves. In addition, three-dimensional radiative PIC simulations indicate that the current sheet that forms beyond the light cylinder is the main site of particle acceleration in plasma-filled pulsars, instead of gaps within the co-rotating magnetosphere. Relativistic reconnection dissipates the magnetic energy which is then converted to energetic particles and high-energy synchrotron radiation. We present self-consistent modeling of pulsar gamma-ray lightcurves and spectra obtained directly from the kinetic simulations, and discuss the results in the context of observed gamma-ray pulsars.

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Session Classification: 18 - Gal. accel. & pulsars