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PICsar: Particle in Cell Pulsar Simulations

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We perform 2.5D axisymmetric simulations of the pulsar magnetosphere (aligned dipole rotator) using the charge conservative, relativistic, electromagnetic particle in cell code PICsar. The particle in cell method is a powerful tool for studying the pulsar magnetosphere, because it can handle the force-free and vacuum limits as well as magnetic reconnection. In particular, dissipative regions in the solution arise self-consistently, since we do not have any explicit dissipation in the code.

The structure of the electromagnetic fields in our simulations is on the whole consistent with the force-free model, and the value of the spin-down luminosity is within $\approx 10\%$ of the force-free value. However, a minimum of $\approx 15\text{-}20\%$ (and as high as 50% depending on the plasma density at the light cylinder) of the electromagnetic spin-down luminosity is transferred to the particles within five light cylinder radii. The energy is transferred to the particles most efficiently near the Y-point and could potentially be radiated in the form of gamma rays. In the future, PIC codes could be used to better constrain the sites of gamma ray emission in the pulsar magnetosphere.

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