Particle Acceleration and Radiation Reaction in Ultra Strong Electromagnetic Waves

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Strongly magnetized and fast-rotating neutron stars are known to be efficient particle accelerators within their magnetosphere and wind. They are suspected to accelerate leptons, protons and maybe ions to extreme relativistic regimes where the radiation reaction significantly feeds back to their motion. In the vicinity of neutron stars, magnetic field strengths are close to and sometimes larger than the critical value of $B_{\rm c} \sim 4.4e9$ T leading to maximal particle Lorentz factors of the order $\gamma \sim 10^9$. In this talk, I will present a recent investigation of particle acceleration and radiation reaction feedback in ultra-strong electromagnetic waves with applications to the neutron star environments where a large amplitude low-frequency electromagnetic wave is launched. I designed a semi-analytical code solving exactly the particle equation of motion, including radiation reaction in the Landau-Lifshits approximation for a null-like electromagnetic wave of arbitrary strength parameter and polarization. Under conventional pulsar conditions, asymptotic Lorentz factor as high as $e8 - e9$ are reached at large distances from the neutron star. However, I demonstrate that in the wind zone, within the spherical wave approximation, radiation reaction feedback remains negligible. My algorithm can straightforwardly be adapted to studies relevant to lasers physics. It can be implemented in any existing PIC code, replacing the numerical pusher with analytical expressions. I will also discuss a possible extension to non-null-like fields.

References

[1] J Pétri, Mon. Not. R. Astron. Soc. **503**, 2123 (2021)

[2] J Pétri, J. Plasma Phys. **86**, 825860402 (2020)