New class of neutral current sheets with a sheared magnetic field in collisionless plasma

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We found a wide class of self-consistent magnetostatic structures with sheared field lines and arbitrary energy distributions of particles in a collisionless plasma. A member of that class is a superposition of two neutral current sheets with orthogonal planar magnetic fields and cylindrically symmetric momentum distribution functions of particles. Each planar current sheet satisfies the stationary Vlasov–Maxwell equations and may have complicated self-consistent spatial profiles of the current density and magnetic field [1].

The resultant configurations can have an almost arbitrary profile of the shear angle of magnetic field, in particular a non-monotonic one. We develop a regular technique to construct such structures and provide a number of new examples, including localized, periodic, and force-free sheared current sheets. We describe limitations on the anisotropy degree of particle distributions and the magnetic-to-particle energy ratio. Those sheets can be either thick or thin with respect to the typical particle gyroradius. Most of the previously known current sheet families with the sheared magnetic field lines, e.g. [2, 3, 4, 5], are included in the suggested class.

We discuss possible applications of our technique for modelling current structures in various space and astrophysical plasmas, both relativistic and non-relativistic.

References

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