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Bow-Shock Pulsar Wind Nebulae: a tale of trails

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Pulsar Wind Nebulae (PWNe) constitute a magnificent lab to investigate high-energy astrophysics in its many facets, from non-thermal emission, to particle acceleration, from relativistic fluid dynamics to anti-matter creation. The group in Arcetri has always been one of the leading team in the study of PWNe, and through the years has developed a vast and advanced suits of numerical tools for their study.

I will present the more recent results, based on state of the art 3D relativistic MHD simulations of the so called Bow Shock Phase of PWNe, aimed at providing a full sampling of the vast parameter space characterizing these objects, in terms of spin-axis inclination, ISM magnetization, pulsar wind energy distribution. I will describe how this has helped us not just to improve our knowledge of the dynamics of these objects, but also to understand the formation of misaligned X-ray trails, and possibly the even more mysterious TeV Haloes, that have catch much attention in the high energy astrophysical community.

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