Ehlers-Kundt conjecture about Gravitational Waves and Dynamical Systems

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ABSTRACT

Ehlers-Kundt conjecture is a physical assertion about the fundamental role of plane waves for the description of gravitational waves. Mathematically, it becomes equivalent to a problem on the Euclidean plane $\mathbb{R}^2$ with a very simple formulation in Classical Mechanics: given a non-necessarily autonomous potential $V(z,u)$, $(z,u) \in \mathbb{R}^2 \times \mathbb{R}$, harmonic in $z$ (i.e. source-free), the trajectories of its associated dynamical system $\ddot{z}(s) = -\nabla_z V(z(s),s)$ are complete (they live eternally) if and only if $V(z,u)$ is a polynomial in $z$ of degree at most 2 (so that $V$ is a standard mathematical idealization of vacuum). Here, we show a proof of the conjecture in the significative case that $V$ is bounded polynomially in $z$ for finite values of $u \in \mathbb{R}$. The mathematical and physical implications of this polynomial EK conjecture, as well as the non-polynomial one, are discussed beyond their original scope.

References

[1] J.L. Flores, M. Sánchez, Ehlers-Kundt conjecture about Gravitational Waves and Dynamical Systems. Preprint 2017. Available at arXiv:1706.03855.