



GUIA DO USUÁRIO



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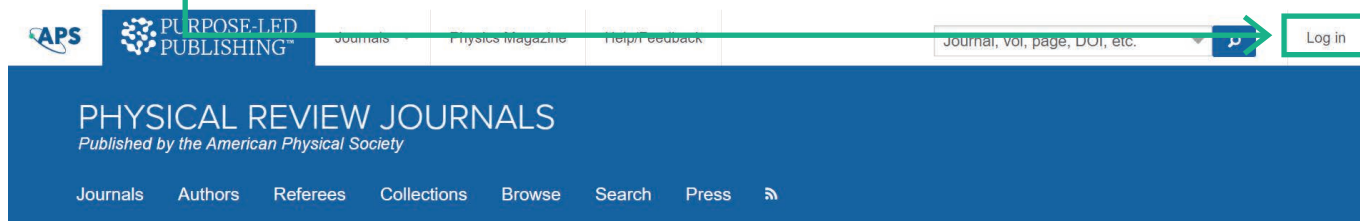
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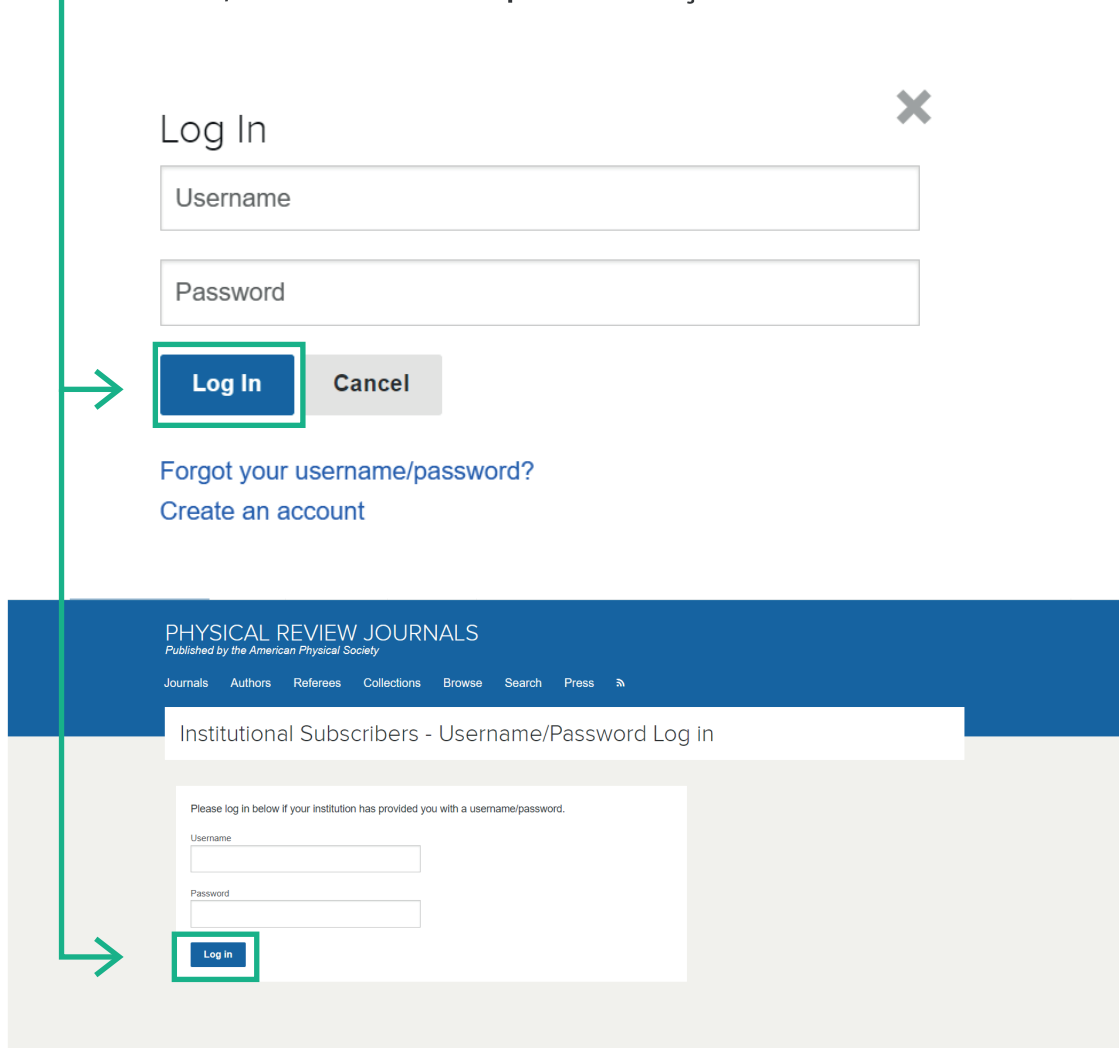
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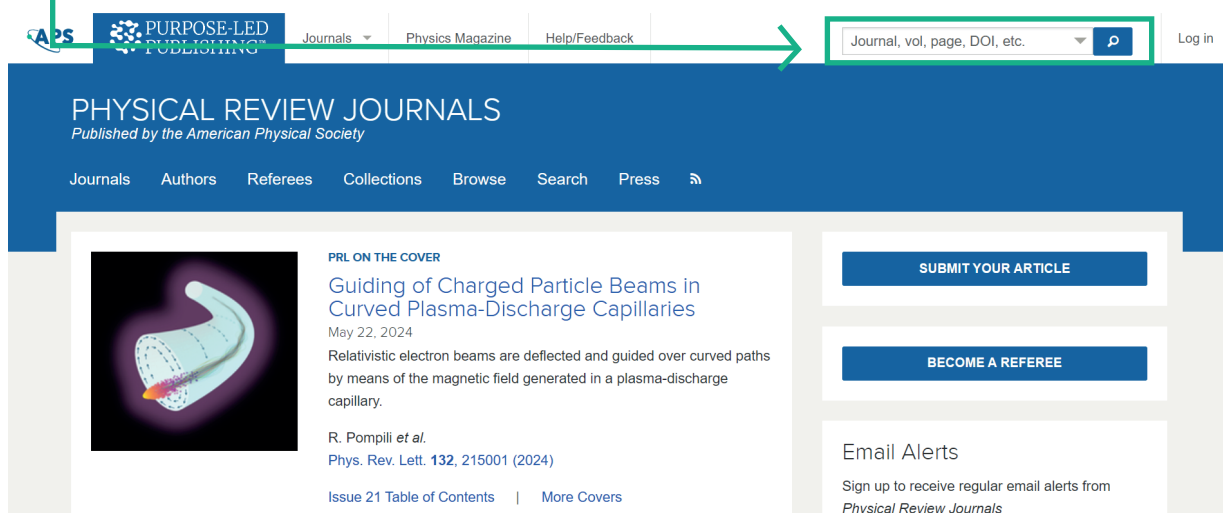
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COMO POSSO PESQUISAR



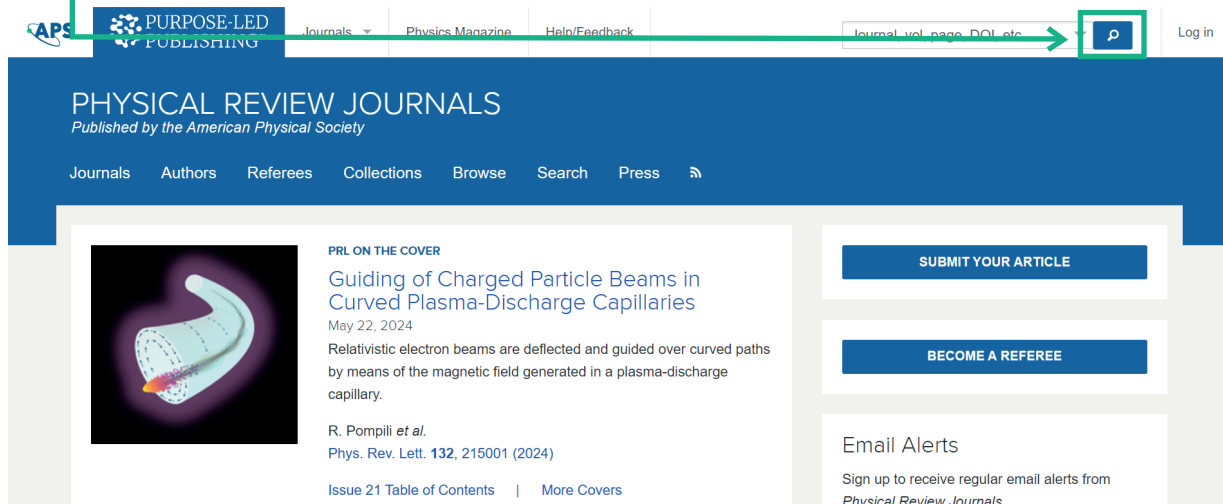
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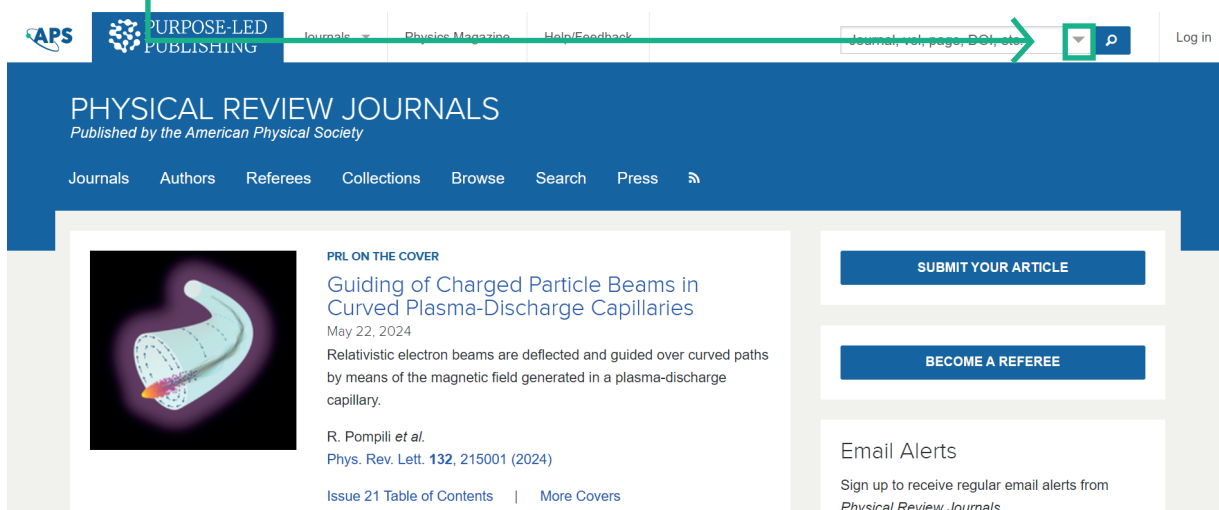


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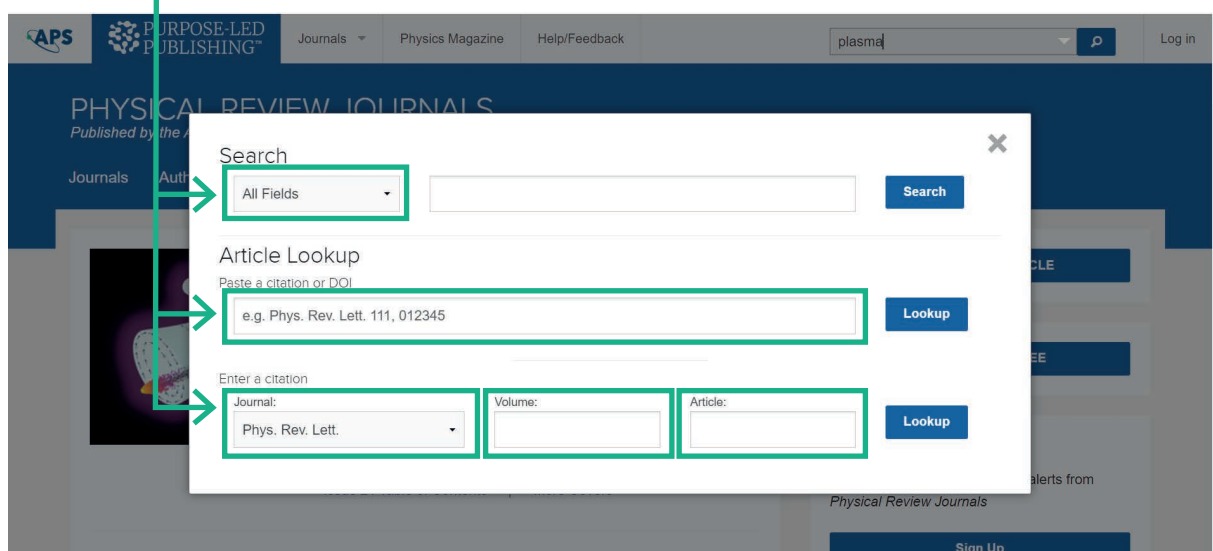
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Light propagation in a plasma on Kerr spacetime. II. Plasma imprint on photon orbits

Volker Perlick and Oleg Yu. Tsupko
Phys. Rev. D **109**, 064063 – Published 21 March 2024

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ABSTRACT

In this paper, light propagation in a pressure-free nonmagnetized plasma on Kerr spacetime is considered, which is a continuation of our previous study [V. Perlick and O. Y. Tsupko, Light propagation in a plasma on Kerr spacetime: Separation of the Hamilton-Jacobi equation and calculation of the shadow, *Phys. Rev. D* **95**, 104003 (2017)]. It is assumed throughout that the plasma density is of the form that allows for the separability of the Hamilton-Jacobi equation for light rays, i.e., for the existence of a Carter constant. Here we focus on the analysis of different types of orbits and find several peculiar phenomena which do not exist in the vacuum case. We start with studying spherical orbits, which are contained in a coordinate sphere $r = \text{constant}$, and conical orbits, which are contained in a coordinate cone $\vartheta = \text{constant}$. In particular, it is revealed that in the ergoregion in the presence of a plasma there can exist two different spherical light rays propagating through the same point. Then we study circular orbits and demonstrate that,

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PHYSICAL REVIEW D **109**, 064063 (2024)

Light propagation in a plasma on Kerr spacetime. II. Plasma imprint on photon orbits

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In this paper, light propagation in a pressure-free nonmagnetized plasma on Kerr spacetime is considered, which is a continuation of our previous study [V. Perlick and O. Y. Tsupko, Light propagation in a plasma on Kerr spacetime: Separation of the Hamilton-Jacobi equation and calculation of the shadow, *Phys. Rev. D* **95**, 104003 (2017)]. It is assumed throughout that the plasma density is of the form that allows for the separability of the Hamilton-Jacobi equation for light rays, i.e., for the existence of a Carter constant. Here we focus on the analysis of different types of orbits and find several peculiar phenomena which do not exist in the vacuum case. We start with studying spherical orbits, which are contained in a coordinate sphere $r = \text{constant}$, and conical orbits, which are contained in a coordinate cone $\theta = \text{constant}$. In particular, it is revealed that in the ergoregion in the presence of a plasma there can exist two different spherical light rays propagating through the same point. Then we study circular orbits and demonstrate that, contrary to the vacuum case, circular orbits can exist off the equatorial plane in the domain of outer communication of a Kerr black hole. Necessary and sufficient conditions for that are formulated. We also find a compact equation for circular orbits in the equatorial plane of the Kerr metric, with several examples developed. Considering the light deflection in the equatorial plane, we derive a new exact formula for the deflection angle which has the advantage of being directly applicable to light rays both inside and outside of the ergoregion. Remarkably, the possibility of a nonmonotonic behavior of the deflection angle as a function of the impact parameter is demonstrated in the presence of a nonhomogeneous plasma. Furthermore, in order to separate the effects of the black hole spin from the effects of the plasma, we investigate weak deflection gravitational lensing. We also add some further comments to our discussion of

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