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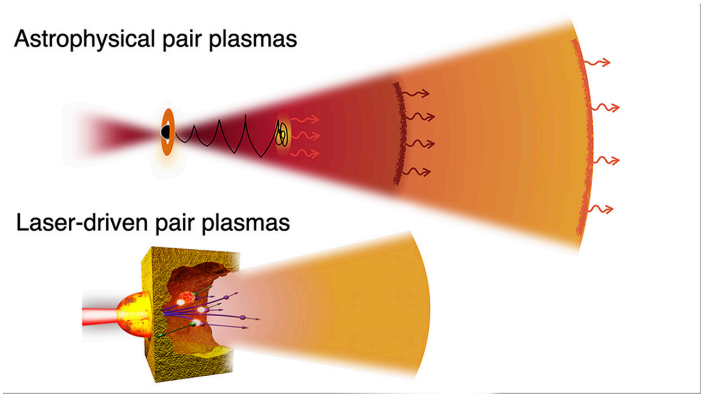
An overview of recent progress highlights remaining challenges and future opportunities associated with producing and studying relativistic pair plasmas in the lab.



Scientists want to study relativistic electron-positron pair plasmas in the lab to learn more about their role in high-energy astrophysical systems, such as neutron stars and black holes, as well as how their processes shape magnetic field dynamics and particle acceleration.

Though it has proved challenging to generate and control relativistic pair plasmas in the lab, Hui Chen and Frederico Fiuza summarize recent progress that has been made both theoretically and experimentally.

“Our goal was for the paper to provide, in one place, clear and organized information about recent progress in using intense lasers to produce and study relativistic pair plasmas,” Chen said. “We hope that it can constitute a useful resource for students and researchers entering the field or interested in laser-plasma physics and/or high-energy astrophysics.”

Their guide summarizes data from approximately 240 corresponding references to familiarize newcomers with this quickly growing field. In addition to reviewing previous work, the authors also discuss remaining challenges, including improving the number of pairs, size, and charge neutrality of systems.

The researchers are optimistic about the field’s prospects. They believe it will be possible to produce relativistic pair plasmas in the laboratory within the next few years, which will allow first-time measurements under a variety of conditions.

“We envision that these advances will also naturally stimulate new research directions. For example, we may learn how to take advantage of plasma pair processes to develop more efficient accelerators and radiation sources,” Fiuza said.

Source: “Perspectives on relativistic electron-positron pair plasma experiments of astrophysical relevance using high-power lasers,” by Hui Chen and Frederico Fiuza, *Physics of Plasmas* (2023). The article can be accessed at https://doi.org/10.1063/5.0134819.