AN ANALYTIC “LENSE” FOR SKYRME-EINSTEIN

An analytical tool developed by the CECs Theoretical Physics Laboratory allows to calculate, for the first time, the gravitational effects of a black hole in the Skyrme-Einstein theory.

Gravitational lenses are one of the most powerful tools for detecting the presence of gravitational field sources (such as neutron stars and black holes). The idea, which originated in Albert Einstein's work, is very simple. The Theory of General Relativity shows that light rays are also affected by the presence of a gravitational field. Therefore, very intense sources of gravitational field are able to divert the path of light rays. These rays, without sources of gravitational fields, would have straight line trajectories.

Predictions of general relativity using gravitational lenses have been among the most resounding successes of Einstein's theory. Thanks to these, by looking at the deviations of light rays (measurement which, experimentally, is not very difficult), it is possible to determine many relevant characteristics of the sources (stars, black holes, etc.) that are deviating light rays.

The most interesting case is probably the use of gravitational lenses to detect black holes. Since black holes do not emit radiation directly, it is very useful to have this tool to detect them. However, there have been few explicit studies of the gravitational effects of "hadronic matter" (particles such as neutrons and protons that are described by the "Skyrme theory"). The reason, is that until recently, finding black holes analytically in the Skyrme-Einstein theory, which describes the gravitational effects of hadronic matter, was considered a very difficult task. However, using an innovative theoretical tool developed by CECs researchers since 2013 in this work recently published by *The European Physical Journal C* it has been possible to analytically calculate for the first time, the effects of a gravitational lens from a black hole in the Skyrme-Einstein theory.

This result makes it possible to determine how hadronic matter affects the gravitational lens in the case of spherically symmetrical black holes in the Skyrme-Einstein theory.

Specifically, the impact of the conclusions of this study, is that given a measurement by astronomers, of a "gravitational lens" event of a spherical black hole using the formulas found in this work, it’s possible to deduce in addition to the mass of the black hole, the value of a

hadronic coupling constant that until now, has been difficult to measure. This work could allow the first direct measurement of this important physical parameter called "Skyrme coupling constant".

In the words of Fabrizio Canfora , a CECs Theoretical Physics Lab researcher and lead author of the study, "it's worth noting that Skyrme's coupling constant, which determines many of the properties of protons and neutrons, has not been directly measured until now. For this reason, the possibility of measuring it using the gravitational lens technique is very interesting, not only for researchers working on black holes, but also for those working on particle physics".

Ref.: Canfora, F., Eiroa, E.F. & Sendra, C.M. Eur. Phys. J. C (2018) 78: 659. https://doi.org/10.1140/epjc/s10052-018-6142-0