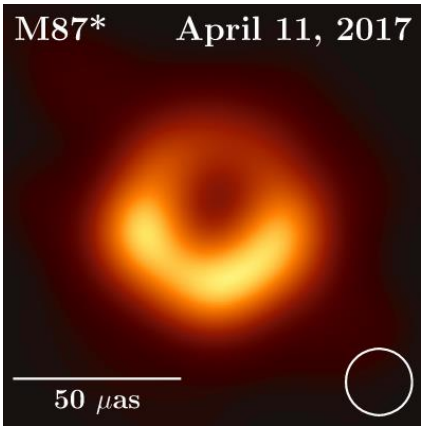
Dr. Mounir Nisse and Dr. Lim Yen Kheng Discover a New Application of Algebraic Geometry in the Effects of Strong Gravity on the Motion of Light

Associate Professor Dr. Mounir Nisse and Associate Professor Dr. Lim Yen Kheng from the School of Mathematics and Physics recently published a journal article titled "*Light-ring pairs from A-discriminantal varieties*" in Physical Review D (SCIE-!1 in Physics, SCIE-Q1 in Astronomy and Astrophysics, 2020 impact factor: 5.296)

As the direct imaging of black holes is becoming a reality, especially with the spectacular accomplishments of the EHT collaboration, studies of light and optical phenomna in the vicinity of strong gravitating sources are becoming important.

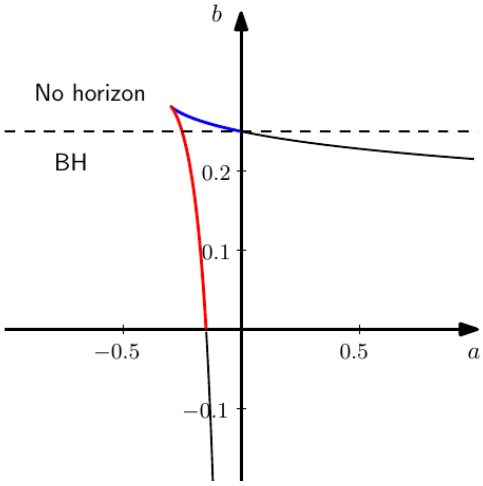


EHT Collaboration, Astrophys. J. Lett. **875** (2019) L1 [1906.11238]

One of the outstanding issues in these studies are the kinds of gravitating bodies that has gravity strong enough to support circular orbits of light around it. Such objects may be black holes, but could possibly be other non-black hole compact objects. These circular orbits of light are known as *light rings*.

In their paper, Lim and Nisse addressed the question using the tools of algebraic geometry. In particular, using the tools of *A*-discriminants. These are mathematical notions which describe the criteria when a polynomial has multiple roots. It turns out that, for certain gravitating sources, its equations of light orbits can be reduced to polynomials for which their *A*-discriminants can be calculated.

Further using a recent theorem by Rojas and Rusek [1612.03458], it was found that for these gravitating sources, light rings form in pairs. The argument lies on Rojas and Rusek's theorem which provides a way to count the number of expected cusps for the graph representing the *A*-discriminant:



One of the implications of Nisse and Lim's result is that black holes can only support *unstable* light rings. This, in turn, lends support black hole spacetimes are potentially *stable*.

This paper is the latest in a line of work by Nisse and Lim in discovering new applications of algebraic geometry in solving various physics problems. The paper can be found at https://doi.org/10.1103/PhysRevD.104.104012.

Associate Professor Dr. Mounir Nisse was an invited researcher at IHES, Bures-sur-Yvette, France before joining Xiamen University Malaysia. His primary focus of research lies in the areas of complex algebraic geometry, computational algebraic geometry, tropical geometry, complex analysis, combinatorics, deformation of singularities, (co)amoebas of complex varieties, and mirror symmetry.

Associate Professor Dr. Lim Yen Kheng received his PhD from National University of Singapore in December 2015, where he then worked as an instructor until August 2019 before joining Xiamen University Malaysia. He has published more than 20 papers in journals including Physical Review D, Classical and Quantum Gravity, *and the* Journal of High Energy Physics. *His research interests are black holes, general relativity, and theoretical/mathematical physics.*