Does geometric optics depend on geometry?

Abraham I. Harte
Centre for Astrophysics and Relativity, School of Mathematical Sciences
Dublin City University, Glasnevin, Dublin 9, Ireland

An immediate answer to the question in the title might be: "Of course geometric optics depends on geometry; it's right there in the name!" However, the point of this talk will be to explain that one might instead say that "Geometric optics does depend on geometry, but only slightly." This is important, in part, because many types of observations attempt to infer the geometry of spacetime using the properties of electromagnetic or gravitational waves which pass through it. Doing so naturally leads to the question of whether or not such inferences are unique: If a particular field is known to be compatible with a particular background metric, is it compatible with other metrics as well? I will explain that in fact, the class of possibilities can be enormous. This is particularly true in the geometric optics approximation, where, for many observables, the class of allowed metrics involves *seven free functions*. Some of these functions may be identified with conformal and Kerr-Schild transformations, but there is much more besides (and it is not gauge). Going beyond geometric optics can provide a somewhat more discerning picture of the underlying geometry, but some observables remain invariant with respect to large classes of metric transformations. This will be discussed as well.