DESIGNING LENSES AND MIRRORS WITH HELP FROM GEOMETRY AND OPTIMAL MASS TRANSPORT

VLADIMIR OLIKER

EMORY UNIVERSITY

ABSTRACT. Systems of lenses or mirrors converting an incident plane wave of a given cross section and intensity distribution into an output plane wave irradiating at a given target set with prescribed intensity are required in many applications. Most of the known designs are restricted to rotationally symmetric mirrors/lenses. In many cases this is a significant limitation. In this talk I will discuss designs with freeform mirrors/lenses, that is, without a priori assumption of rotational symmetry. Assuming the geometrical optics approximation, it can be shown that the functions describing such freeform mirrors/lenses satisfy Monge-Ampère type partial differential equations (PDE's) derived from the basic laws of geometrical optics. However, because of strong nonlinearities investigation of such PDE's is difficult and many basic questions are open. Fortunately, by extending the classical notions of the Gauss map and of the Legendre transform some of these problems can also be formulated (in weak form) as problems in calculus of variations in which instead of solving the nonlinear PDE's one needs to find extrema of some Fermat-like functionals. Moreover, these functionals are interpreted in a natural way as cost functions in optimal transportation problems. This approach was successfully applied in several design problems and allowed to prove existence, uniqueness and numerically calculate solutions with high accuracy by methods based on linear programming. I will describe these ideas in the case of the "two-lens" design problem.