Probing spacetime curvature using geometric optics

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We discuss how one can probe the spacetime curvature using purely optical measurements. We consider observables like the linear image distortion, the parallax, the position drift (proper motion) and the redshift drift of a small luminous body, registered by any distant observer, and in any spacetime. We show that all these observables can be expressed via the curvature tensor along the line of sight as well as the 4-velocities and 4-accelerations of the source and the observer measured in their respective local inertial frames. Combining those observables we may also obtain quantities which are completely independent of the momentary motions of both the observer and the source. These quantities measure the impact of curvature on nearby null geodesics. We show that one of them allows for a tomography-like determination of the matter content along the line of sight. Potential applications of the formalism includes cosmology (the drift effects and parallax) and other branches of relativity.