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Sommario/riassunto

This thesis focuses on the study of phonon polaritons—hybrids of infrared light and lattice vibrations—in van der Waals polar materials, particularly strongly anisotropic (hyperbolic) ones. It combines experiments, analytical theory, and numerical simulations to explore nanoscale optical phenomena that challenge our conventional understanding, such as negative reflection, anomalous refraction and polariton canalization. These studies have paved the way for practical applications in integrated flat optics, such as planar lenses and resonators for nanoscale light. The thesis also introduces the emerging field of twistoptics, aimed at controlling the propagation of light at the nanoscale by stacking slabs of van der Waals materials at different rotation angles, and introduces innovative approaches to tune polariton properties both passively and actively. In addition to providing a solid foundation for future advancements in planar nano-optical devices and helping lay the fundamentals of light-matter interactions in hyperbolic van der Waals materials, the thesis's didactic approach makes complex phenomena accessible to a broad audience.