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Biprism interferometry with electrons and ions, a valuable tool to study the fundamentals of quantum mechanics and quantum statistics

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Our miniaturized electron biprism interferometer [1] proved to be many orders of magnitude less sensitive to mechanical and electromagnetic disturbances than conventional interferometers (modified electron microscopes). Experiments so far inconceivable with electron waves, e.g., to rotate an electron interferometer on a turntable and to prove the Sagnac phase shift [2, 3] or to realize biprism interferences with He-ions [4] with wavelengths as small as 0.3 pm became reality. A crossed-field analyzer (Wien filter) in the beam path of our electron interferometer allows to introduce electric and magnetic Aharonov-Bohm phase differences and transit time differences between the interfering wave packets [5]. For wave packet shifts introduced by the Wien filter which exceed the coherence length, which-path information is available in principle, leading to vanishing fringe contrast. Since which-path information is not read out in this experiment, fringe contrast can be restored by compensating the longitudinal shift in a second shifting device. Only recently we succeeded to demonstrate that electrons arrive at two coherently illuminated detectors 'antibunched' [6], i.e., according to the demands of Fermi statistics. At present, our intertest is focused on decoherence. Coherently split electron waves propagate over a resistive plate. Which-path information of the electrons decreases with increasing height of flight. In turn the contrast of the fringes increases [7, 8].

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