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Fast birefringence measurement and compensation using a pair of identical liquid crystals.

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KAGRA operates at cryogenic temperature, therefore uses sapphire substrates as its test-masses. Next generation of gravitational wave detectors will also use crystalline substrates, possibly sapphire or silicon. All these materials are birefringent which can spoil both the sensitivity and duty-cycle of the detectors and therefore substrates with lowest possible birefringence are mandatory.

KAGRA collaboration has two experiments which measure the birefringence of the 22kg sapphire substrates within a duration of weeks. It is planned to increase the mass of the test-masses to the hundred-kg scale making the current birefringence characterization measurements impractical.

Here, we propose to use a pair of identical liquid crystals to measure and compensate birefringence of substrates with arbitrary size. We are now developing such experiment which will decrease the characterization duration by at least a factor of two and possibly down to the second scale while demonstrating for the first time birefringence compensation for gravitational wave detectors.

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