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A polarized view on how to design astronomical instrumentation

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Ideally, our astronomical instruments measure a complete five-dimensional phase space: intensity and polarization (1) as a function of sky coordinates (2,3), wavelength (4), and time (5). Inclusion of polarimetric capabilities almost always provides unique scientific benefits, but also almost always leads to tensions within the optimization of the optical system design. All optical components for image formation and spectroscopic analysis induce instrumental polarization effects at some level, and polarization modulation optics necessarily compromise temporal, spatial and/or spectral range/resolution.

I will provide an overview of the implementation of polarization measurement techniques within astronomical instruments, and discuss their system-level trade-offs. I will discuss polarization modulation in the temporal, spatial, and spectral domains, and combinations thereof, to maximize the measurement efficiency, and to minimize the susceptibility to systematic (differential) effects and obtain the best possible polarimetric sensitivity. Moreover, I will discuss calibration techniques to mitigate a myriad of instrumental polarization effects with the goal to obtain the best possible polarimetric accuracy. I will provide examples from existing instruments at e.g. the VLT, and from more experimental concepts that we are developing in Leiden.

Finally, I will provide a sneak preview of our design for a polarimetric upgrade of the VLT Survey Telescope, that would enable unique deep and wide-field polarimetric survey capabilities, and rapid follow-up of transient events.

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