Polarimetry in X- and Gamma-Ray Astronomy: the Ultimate Dimension

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Polarimetry has been a powerful diagnostic tool in radio, microwave, and visible astronomy, providing details of photon production mechanisms on much smaller scales than can be directly imaged or deduced from photon intensity and energy alone. While polarimetry at other these wavebands (radio, microwave, and optical) is an established technique, high energy astrophysics lags far behind in this respect. Yet polarization analysis has the potential of revealing many details about the magnetic fields, geometries, and emission mechanisms found in high energy emitting sources. Deviations from spherical symmetry and/or the presence of ordered magnetic fields give rise to polarized radiation: some examples include anisotropy in solar flares, the presence of jets in microquasars and blazars, accretion disks around stellar and massive black holes, accreting and rotation-powered pulsars, and beams in gamma-ray bursts. In addition, null polarization detections from gamma-ray bursts at x-ray energies have been used as a test of fundamental physics by placing limits on the possible violation of Lorentz invariance.

The first attempt to measure astrophysical x-ray polarization was made in 1969 by R. Novick and his team at Columbia University. These measurements, using rocket payloads, provided the first detection of polarization of the Crab pulsar (5–20 keV) in 1971. This success led to a polarimeter on the OSO-8 mission that obtained upper limits to the phase resolved polarization of the Crab pulsar. Despite these early successes and a recognition that polarization capability can provide a collection of papers describing the current work on instrumental techniques maturing, the guest editors of this special section, along with JATIS editor-in-chief Mark Clampin, agreed to a solicitation of manuscripts on high-energy polarization. Our goal was to bring together in one place a collection of papers describing the current work on high-energy polarization. It is our hope that this collection of papers will motivate future instruments and future sub-orbital and space missions.

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