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Editorial

The Conference *Blazars through Sharp Multi-Wavelength Eyes*

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Blazars are active, galactic nuclei with jets of magnetized, high-energy plasma that flow outward from the center of the host galaxy at near-light speeds. Such systems, powered by black holes with masses of order 0.1–10 billion solar masses, that are accreting material from their environment at rates measured in solar masses per year, generally produce a pair of such jets launched in opposite directions. In the case of a blazar, one of these jets points within about 10° of the Earth's line of sight. The ultra-high velocity of the plasma results in a myriad of relativistic effects that include strong beaming of the radiation, shifting of emission to higher frequencies, and shortening of time-scales of variability. As a result, blazars appear to be the most luminous cosmic objects that persist for more than a few minutes. If we could see the sky with eyes sensitive to either microwave or gamma radiation, it would be blazars, rather than planets and stars, that we would see dominating the sky outside the main band of the Milky Way. This powerful radiation is observed to change in brightness on time-scales as short as minutes, yet there is strong evidence that this rapid variability often occurs one or more parsecs from the black hole, where longer time-scales would normally be expected.

Because of these extreme properties, blazars are among the most interesting objects in the universe. After about half a century of effort, astrophysicists continue to struggle to explain the phenomena associated with them. The basic paradigm of a relativistic plasma jet pointing nearly toward us, devised in the 1970s, remains the dominant framework for exploring the physics that gives rise to the observed events such as sudden flares of emission across a wide—or, mysteriously, sometimes rather narrow—frequency range of the electromagnetic spectrum. However, many of the details remain elusive, involving complex high-energy plasma interactions, relativistic shock waves, and other exotic physical processes that are difficult to study in the laboratory or even in the solar system where in situ measurements are possible with space probes.

Given that the physics of blazars goes well beyond familiar situations, astrophysicists look to observations for motivation and guidance to develop speculative models when more conventional explanations do not work. This has led to a golden age of astronomical instruments and observational programs that are in the process of gathering comprehensive data sets which include time-dependent spectral energy distributions that extend from radio frequencies to TeV γ-ray energies; very long baseline interferometry (VLBI) that produces microwave images of jets on scales measured in micro-arcseconds that usually reveal apparent superluminal motions of emission features in the jets; and monitoring of polarization in these images as well as integrated over the entire object at radio to optical wavelengths.

In order to consolidate and discuss recent theoretical developments and the rich new datasets, Dr. José L. Gómez and an international committee of colleagues organized a conference in Málaga,

Spain, from 30 May to 3 June 2016. The title of the meeting, *Blazars through Sharp Multi-wavelength Eyes*, encompasses the wide range of current astronomical techniques that are addressing the grand problem of explaining blazars. The conference attracted over 160 scientists from around the world and included many of the leading experts in various sub-fields related to blazar research.

The timing of the conference was well-matched to the availability of premier high-energy facilities, such as the *Fermi* Gamma-ray Space Telescope; the *Chandra*, *Swift*, *NuSTAR*, and *Astrosat* X-ray satellites; new ultra-high resolution arrays such as the Event Horizon Telescope (EHT; VLBI at a wavelength of about 1 mm), RadioAstron (antenna in space to form a VLBI array with radio antennas on the ground), and ALMA (Atacama Large Millimeter/submillimeter Array in Chile); sensitive, very high-energy gamma-ray Cherenkov detectors, and long-term monitoring with the Very Long Baseline Array, Global Millimeter-VLBI Array (GMVA); *Swift* optical and ultraviolet detectors, and numerous ground-based optical-infrared telescopes. The imaging is providing information on the location and often changing magnetic field structure of active regions in the jet. It also produces a conundrum, revealing emission over such compact areas of the sky that a higher X-ray flux than is observed should be produced. The EHT is on the verge of imaging radiating regions in the immediate environment of black holes at the center of the Milky Way and of the giant elliptical galaxy M87.

The meeting celebrated Professor Alan Marscher's contributions to observational and theoretical blazar research over the first 40 years of his career. A professor and past chair of Astronomy at Boston University, Marscher was the first to combine VLBI with X-ray and γ-ray observations to study the relationship between the compact radio-emitting features and high-energy emission. He also produced one of the earliest emission models of jets, as well as (with Walter Gear, now at Cardiff University, UK) a widely-used shock model for blazar multi-wavelength variability. He leads a group at Boston University and a world-wide collaboration of astronomers that is now engaged in a comprehensive observational study of radio to γ-ray variations, including many-epoch VLBI imaging with the Very Long Baseline Array (VLBA) and GMVA at millimeter wavelengths, as well as polarization monitoring at optical wavelengths and with the VLBI images. Marscher continues to model blazar emission with a many-zone computer code that combines the effects of turbulent plasma with shock waves in a jet. He has mentored many students and postdocs, most of whom have remained productive researchers in the field.

The conference featured a combination of invited and contributed talks, as well as many poster presentations, all of high quality. The topics ranged from historical overviews, to descriptions of the current state of the field from both an observational and theoretical standpoint, to prospects for future instruments that can be applied to further explorations of blazars. Many of the attendees have converted their presentations to papers included in the proceedings published here, in the journal *Galaxies*. This provides an opportunity for the reader to taste some of the flavor of the meeting and to be informed about the state of the field in mid-2016. As can be verified by reading these papers, blazars remain both surprising and enigmatic in many ways. It seems as if Nature is purposely defying the attempts of humans to understand its rich array of cosmic phenomena!