PACA_PolNet: Polarimetric Network to Measure the Inner Solar Coronal Polarization

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A two-site polarimetric telescope network, PACA_PolNet (Pro-Am Collaborative Astronomy_Polarimetric Network) will measure temporal and spatial polarization of the inner solar corona over a range of 1.3 – 2.2 solar radii, a region not probed by spacecraft nor ground-based observatories during the total solar eclipse on 17 August 2017. The corona, thin, tenuous and always present, is dominated by sunlight and is not observable naturally except during total solar eclipses. Polarimetric brightness measurements in this range will provide insights into the source of coronal heating and why the corona, farther from the sun's atmosphere, is hotter than the visible surface of the sun or photosphere. Although the light from the corona is composed of three components K-corona or continuum scattering by free electrons; F-corona or Fraunhofer scattering by dust particles; E-corona or emission spectra produced by ions present in the coronal plasma, the inner solar corona is dominated by the K-corona scattering, which is polarized. Polarimetric observations during total solar eclipses provides information about the polarization brightness, pB, which is related to the local electron density. The outer part of the corona becomes the solar wind that moves outward through the solar system and interstellar space, interacting with planetary atmospheres and other solar system objects, creating space weather. Mapping of the polarimetric signature of inner solar coronal features provides a measure of electron density critical to modelling coronal waves, a possible source of coronal heating. Since the total time of totality of the 2017 eclipse is little more than 2 minutes at a given location, a network of multiple sites extends the "time" of totality by the sum of totality over the number of sites, in this case, to over 4 minutes. The PACA_PolNet builds on the heritage of NASA Citizen CATE project (PI: M. Penn, NSO) and the polarimeter POISE used for the 1998 total eclipse observations by Co-I Elmore from Curaco, Venezuela. The calibration and data reduction of the data is similar to the approach of the POISE data calibration and reduction. The PACA_PolNet has the potential expansion of the network from 2 to multiple sites and its portability allows for the mobility of the network for the measurements of the inner solar corona during future total solar eclipses, the next one occurring in 2024. Our two sites for Eclipse 2017 are: (1) Tetonia, Idaho, where the duration of the eclipse is over 2 minutes, close to a Citizen CATE-site. (2) Carbondale is the center of totality of Eclipse 2017, with greatest duration of the eclipse being 2 minutes 40 seconds, and a Citizen CATE-trained site. It is anticipated that approximately 1000 images per minute for each of the two states of polarization, for each site, with duration of eclipse totality being approximately at least 2 minutes and 30 seconds, about 2500 images will be acquired.

Our industrial partner is Daystars Filters, the sponsor of the CATE-telescopes. The individual nodes will be the based on the heritage of the citizen science experiment, Citizen CATE – which is geospatial network of 60 identical telescope – camera- filter –computer system, sponsored by DayStar Filters, and MATLAB. The basic original CATE telescope consists of 90-mm f/5.5 doublet refractor and an equatorial mount, with a battery –powered right ascension drive, and on a tripod. A 4-megapixel rapid-readout detector will be placed at prime focus and will be powered by a laptop collecting images at roughly 10 frames per second. The polarimeter consists of a quarter wave retarder, liquid crystal variable retarder, and a linear polarizer. The telescope/polarimeter operates in broadband white light. The telescope field of view is 2 solar diameters. This device will screw on to the back end of a CATE-telescope, just in front of the

camera. The polarimetric version of the instrument will demonstrate the ability to perform polarimetry without compromising the intensity-only CATE experiment. It is estimated that this configuration of the polarimetric telescope will yield approximately 1000 images per minute for each two states of polarization, for a total of approximately 2500 images of polarization. The date pipeline, including calibration and reduction of the observations will follow similar techniques as for Citizen CATE telescopes.

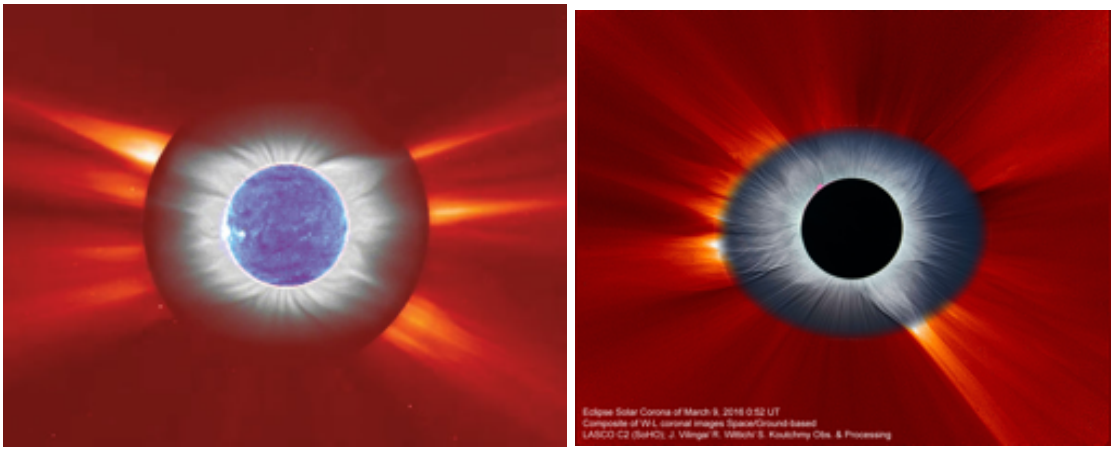

Figure (1): Composite images of the corona during total solar eclipses of 2006 (left; credit…) and 2016 (right; credit). The outer corona (red) is imaged from space by NASA/SOHO/LASCO instrument; the inner solar corona (white) is from ground-based observers and the image of the sun is shown on blue (left image) and is occulted (black in the right image). The inner solar corona, dominated by K-corona, and polarized, will be probed by the PACA_PolNet from two sites during the total solar eclipse in August 2017.

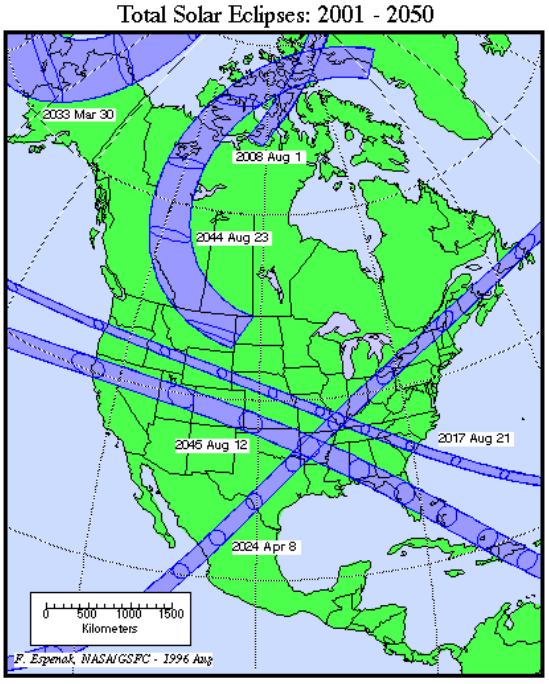

Figure (2). The paths of several US continental total solar eclipses are shown in this schematic (Credit: F. Espenak, 1996): eclipse 2017 is followed by eclipse 2024, with Carbondale, Il, being the center of both eclipses. PACA_PolNet, mobile and multiple site network, potentially can dramatically improve the inner solar coronal observations.

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