Space Weather

COSMO: The Coronal Solar Magnetism Observatory
Anticipating solar storm impacts

Spring 2014 Update

I. Description

Society is becoming increasingly reliant on technologies that are susceptible to damage by so-called space weather events. These events are eruptions of high-energy radiation, energetic particles, and ejected mass from the Sun that affect critical systems on Earth and in space. Communication systems, GPS, power transmission grids, and human space flight are all vulnerable. Since these eruptions originate in the solar corona and are magnetically driven, remote sensing of magnetic fields in the solar corona is crucial to understanding and predicting the Sun’s creation of space weather.

The Coronal Solar Magnetism Observatory (COSMO) is a proposed suite of complementary ground-based instruments designed to do just this—study magnetic fields and plasma conditions in the solar corona and allow for better predictions of their impact. The central instrument is a large (1.5m-aperture) coronagraph that will obtain daily measurements of the strength and direction of coronal magnetic fields over an unprecedented 1-degree field of view (COSMO-LC). The two supporting instruments in the suite measure properties of magnetic fields in the solar chromosphere (COSMO-ChroMag) and the density of electrons in the corona (COSMO-KCor).

When brought online, COSMO will drive understanding into the processes that lead to solar eruptions and support the capability to predict the occurrence and geoeffectiveness—the likely impacts on Earth and near-Earth systems—of solar storms.

The recent decadal survey sponsored by the National Academy of Sciences recommended that the COSMO project be funded (Solar and Space Physics: A Science for a Technological Society, 2012). This recommendation reflects the maturity of COSMO as a concept, as well as the crucial need for society to understand and predict space weather.
II. Status

The first COSMO instrument to come online, COSMO-KCor, was constructed over the past four years with funding provided from the National Science Foundation (NSF). It was brought online at NCAR’s Mauna Loa Solar Observatory in September 2013. Data from COSMO-KCor are freely available from the MLSO website. Through the analysis of the polarization of light scattered by electrons in the solar corona, COSMO-KCor is able to map coronal density every 15 seconds in order to observe rapidly evolving coronal mass ejections.

A prototype of the COSMO-ChroMag instrument obtained first-light measurements of the chromosphere during the summer of 2013 from NCAR’s testing observatory in Boulder, CO. It is currently undergoing modifications and will collect observations again in summer 2014, with a planned deployment to the MLSO at the end of 2014. The COSMO-ChroMag instrument utilizes a filter that can isolate light emitted from various layers of the solar atmosphere and infer the strength and direction of magnetic fields through this 3-dimensional volume.

The centerpiece of the COSMO suite of instruments is the Large Coronagraph, COSMO-LC, which will be the largest refracting telescope in the world. Its innovative design employs a 1.5-m objective lens to observe the corona over a 1-degree field of view with a spatial resolution of 2 arcseconds. Post-focus instruments will use COSMO observations to analyze the polarization signatures of the emitted radiation and infer the direction and strength of coronal magnetic fields, as well as the physical properties of the coronal plasma, including temperature, density, and velocity.

The design of COSMO-LC has been developed over the past 10 years with NSF support. Funding of this development extends through the preliminary design phase, which concludes in summer 2014 with a preliminary design review. Cost estimates obtained to date from vendors confirm the feasibility of constructing COSMO-LC over 5 years for a cost of approximately $20M.

Building on proven prototypes, COSMO will provide unique observations not duplicated by any current or proposed facility. It offers answers to the questions that operators of critical infrastructure need to know:

- When will solar eruptions happen?
- When they happen, are they directed toward Earth?
- If so, will they have the characteristics we know to be damaging?