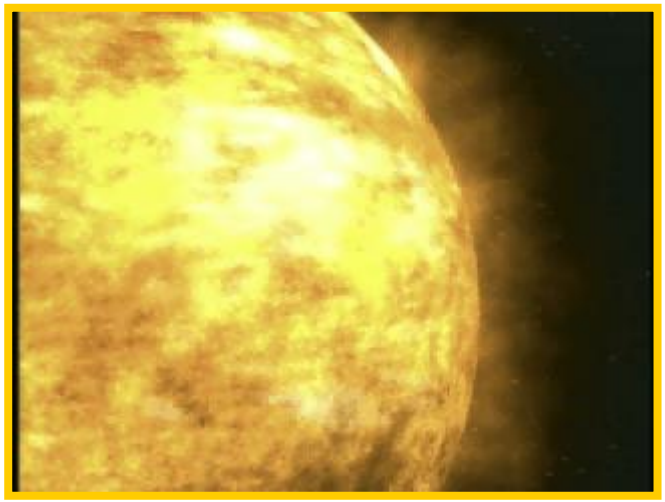
SHINE & AFOSR: AF Research in Solar Physics

August 2002



Click on Image to Begin Animation

Celebrating 50 Years of Basic Research

Paul Bellaire

Program Manager, Space Sciences

Air Force Office of Scientific Research

Air Force Research Laboratory

AFOSR Space Sciences: Supporting SHINE Research Goals

Description

Partnering, Results, & Transitions

Future Trends

- AFOSR routinely transfers research results to operational DoD and NOAA solar physics and space weather forecasters in Boulder, CO, and Omaha, NE
- AFOSR shares funding for the Sacramento Peak National Solar Observatory in New Mexico with the NSF Astronomy Division (20% AFOSR, 80% NSF)
- AFOSR and two NSF divisions have collaborated on funding the USAF's AEOS Telescope on Maui for cutting-edge astronomy, astrophysics, advanced adaptive optics instrumentation, and upper atmospheric physics
- AFOSR remains a key player (along with ONR) in the National Space Weather Program (NSWP) and the DoD National Security Space Weather Architecture
- AFOSR is poised to leverage NASA's new "Living With A Star" solar physics initiative by sponsorship of two solar physics MURIs and a modeling center at Goddard Space Flight Center

NATIONAL SOLAR OBSERVATORY
SACRAMENTO PEAK
SUNSPOT, NEW MEXICO, U.S.A.

LIVING WITH A STAR
LWS
NASA

SPACE ENVIRONMENT CENTER
NOAA SEC

AIR FORCE WEATHER AGENCY

NSF

NASA

ONR

The CCMC: An Innovative Multi-agency Collaboration

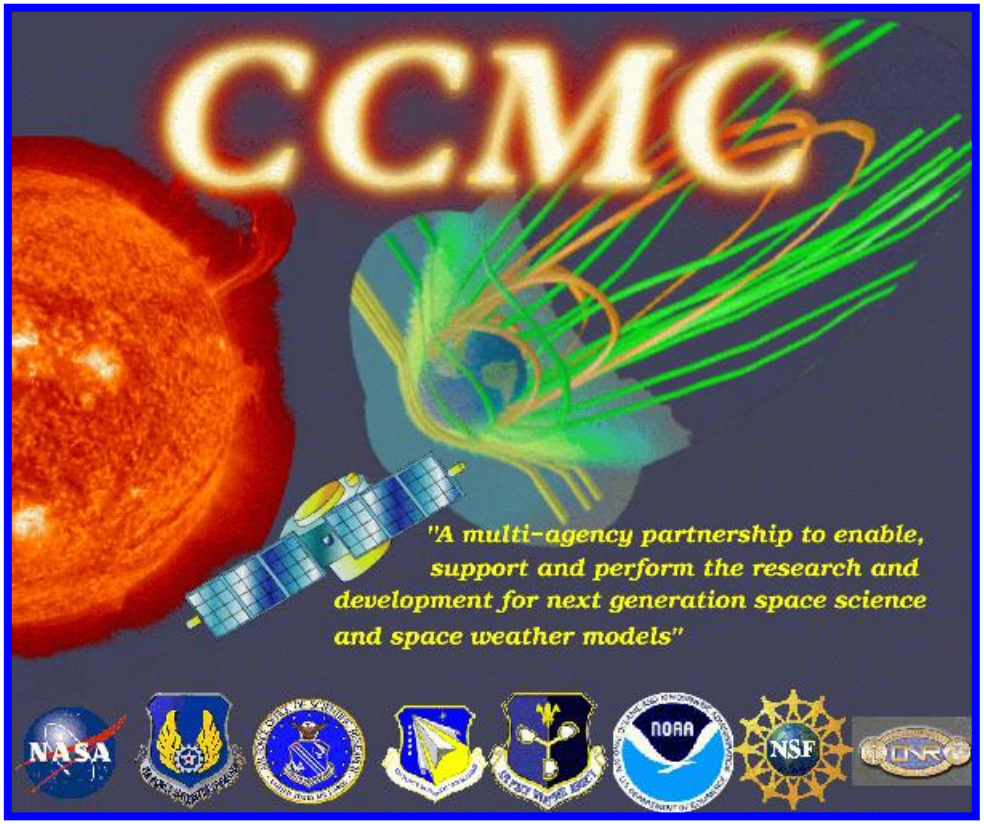
Description

Partnering, Results, & Transitions

Future Trends

AFOSR enabled a new Space Weather Modeling facility at Goddard Space Flight Center, Maryland

- *The Community Coordinated Modeling Center (CCMC) for space weather is an innovative multi-agency (USAF, Navy, NASA, NSF, NOAA) collaboration aimed at improving operational USAF and NOAA space forecasting*
- *First modeling transition made to Air Force space operations in late 2001*



http://ccmc.gsfc.nasa.gov

Advanced Technology Solar Telescope
[Sponsored by the NSF and AFOSR]

NSO ATST Homepage - Microsoft Internet Explorer

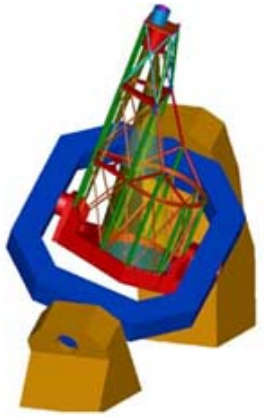
File Edit View Favorites Tools Help

Back Search Favorites History

Address http://www.sunspot.noao.edu/ATST/

NSO

National Solar Observatory
Advanced Technology Solar Telescope



The Advanced Technology Solar Telescope (ATST) represents a collaboration of 22 institutions, reflecting a broad segment of the solar physics community, who propose to build the next generation ground-based solar telescope. With its unprecedented 4-m aperture, integrated adaptive optics, low scattered light, infrared coverage, and state-of-the-art post focus instrumentation the ATST will be the largest and most capable solar telescope in the world. It will be an indispensable tool for exploring and understanding physical processes on the Sun that ultimately affect Earth. The ATST will uniquely resolve fundamental length and time scales of the basic physical processes governing solar variability. Just as other fundamental problems in atomic, nuclear, and gravitational physics were revealed through earlier studies in solar physics, we expect the ATST will have broad impact on astronomy, plasma physics, and solar-terrestrial relations.

Two New AFOSR MURIs

Collaboration with AFRL, ONR, NRL, NOAA

Description

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Future Trends

http://solarmuri.ssl.berkeley.edu/index.html

"Understanding Magnetic Eruptions On the Sun and Their Interplanetary Consequences"

PI: Dr. George Fisher
UC Berkeley
9-University Team

SPACE SCIENCES LABORATORY
UNIVERSITY OF CALIFORNIA BERKELEY

"Comprehensive Solar-Terrestrial Environment Model (COSTEM) for Space Weather Predictions"

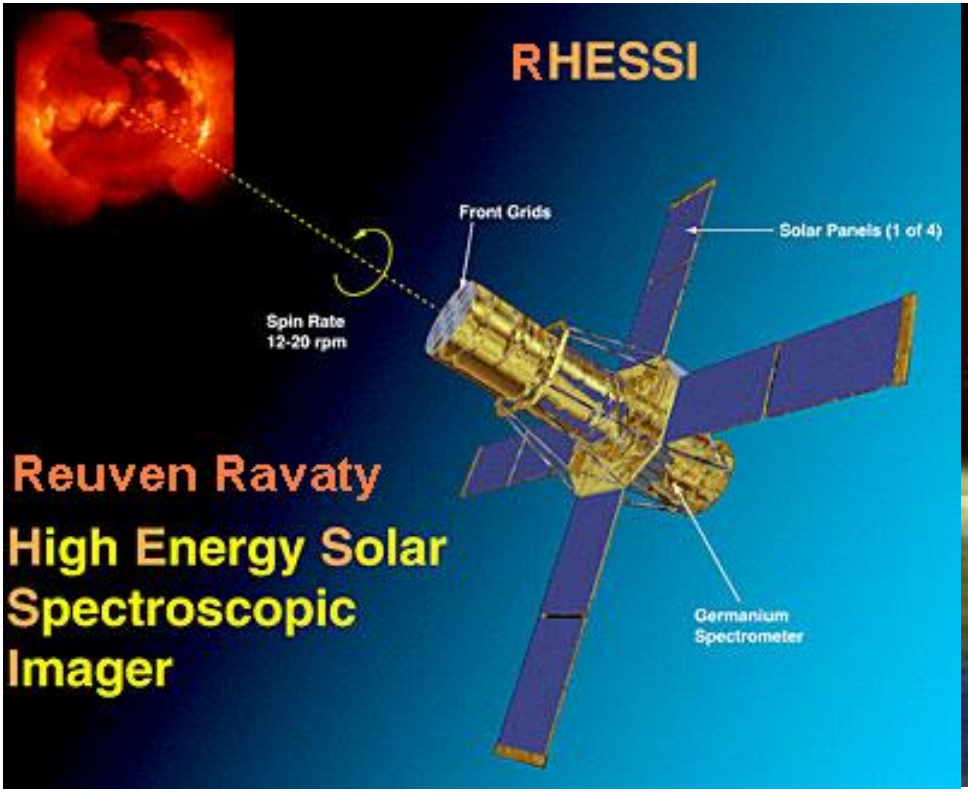
http://csem.engin.umich.edu/

PI: Dr. Tamas Gombosi
University of Michigan
6-University Team

Early MURI Results

New Spacecraft Managed by Berkeley Team

MURI TEAM LEVERAGES SOLAR PHYSICS OBSERVATIONS WITH RHESSI

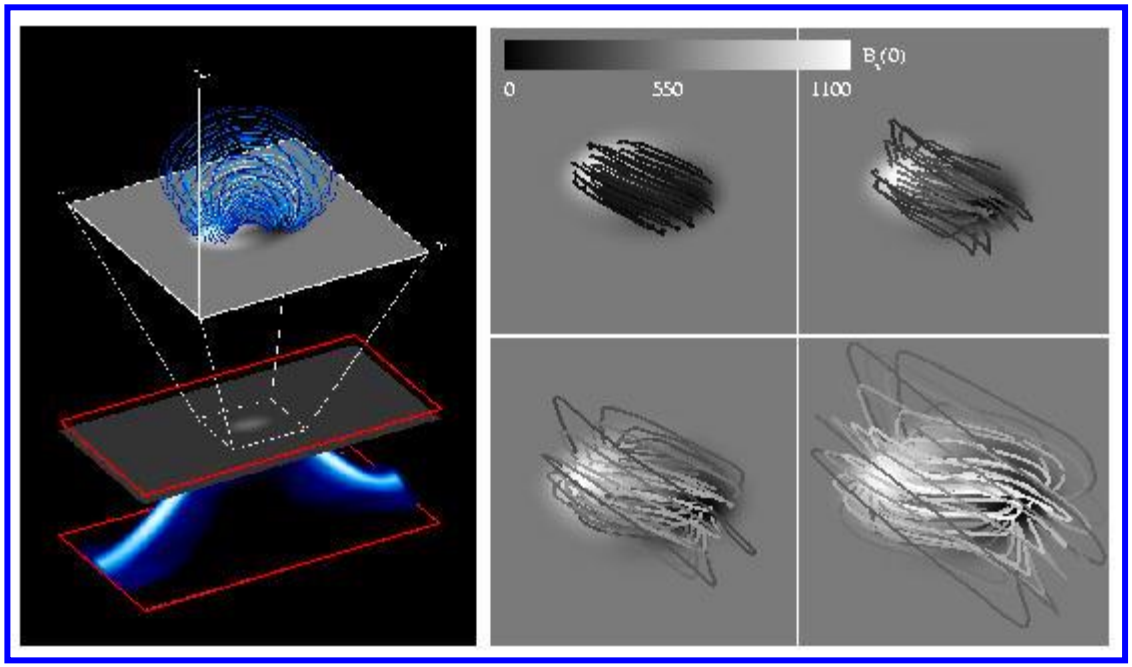


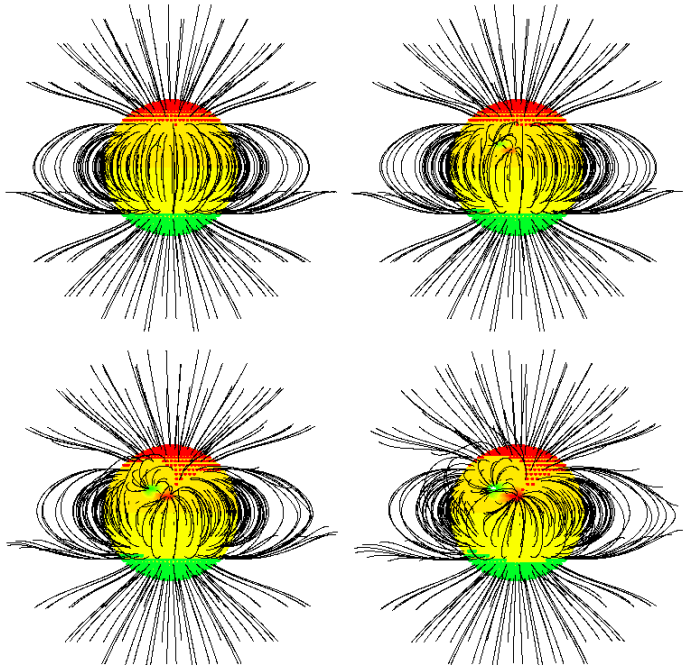
RHESSI offers solar physicists new capability: (1) the first ever X-ray and gamma-ray images of flares from 100 keV to 20 MeV; (2) the first ever nuclear gamma-ray line spectroscopy of solar flares; (3) RHESSI images flares in X-rays with an angular resolution of 2 arcseconds, a factor of three better than previously possible; and (4) RHESSI measures X-ray and gamma-ray spectra with less than 1 keV energy resolution, a factor of 20-40 better than previously possible with scintillation counters.

Early MURI Results

New Solar Physics Simulations by Berkeley Team

MURI MODELS NOW COMPARED TO GROUND- & SPACE-BASED DATA





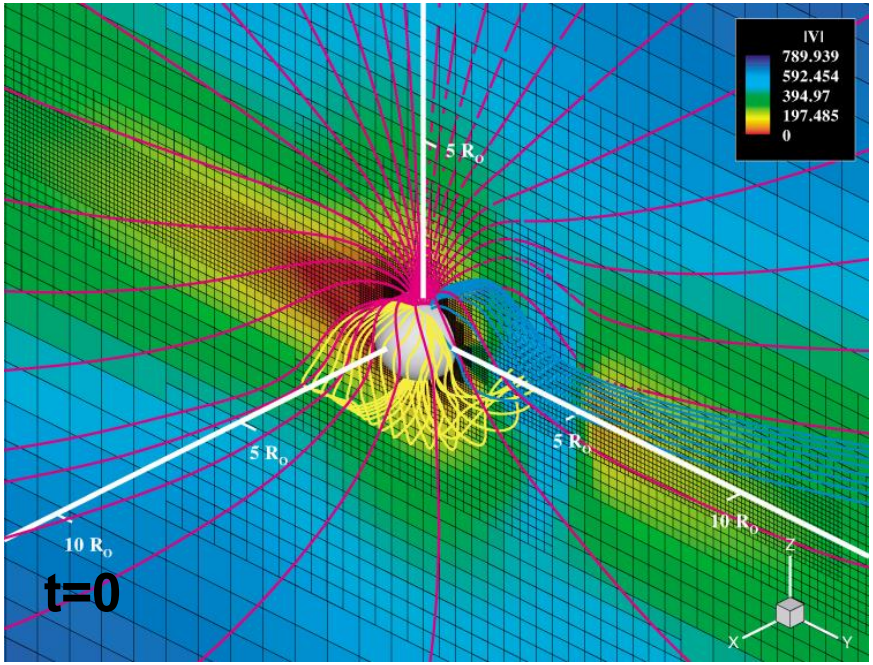
The left panel shows a twisted magnetic field loop configuration, computed using anelastic magnetohydrodynamic simulations of solar magnetic flux, emerging through the photosphere and corona (red box). The expanded blue loops at the top of the figure and the four gray-scale panels show computed coronal field line morphology emerging.

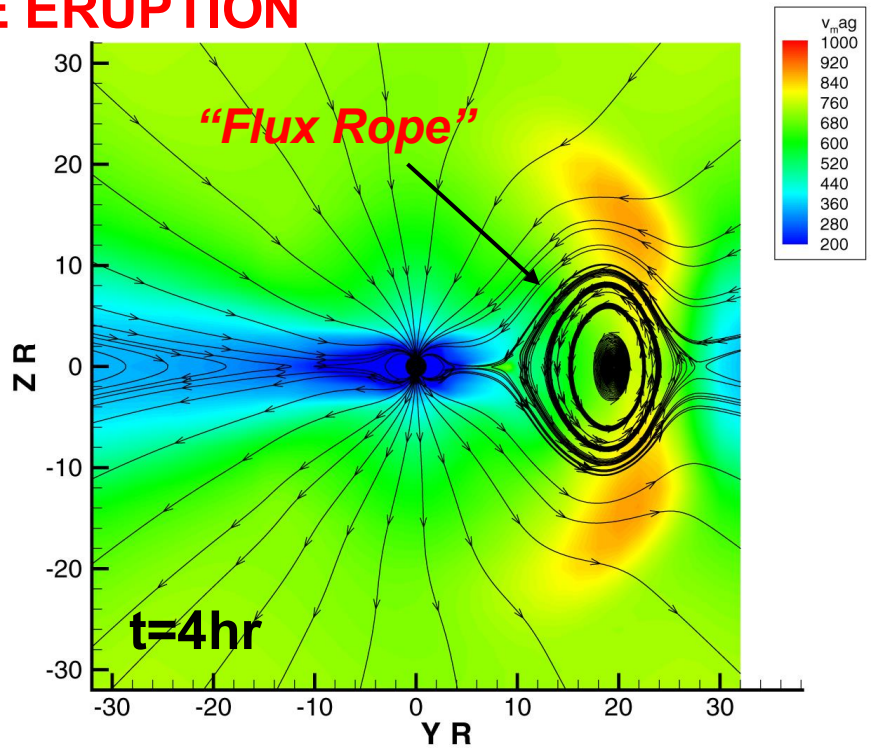
The red-green-yellow figure on the right shows modeled field lines (black) and coronal holes (red for positive polarity and green for negative). As an active region emerges, the coronal hole extends further toward low latitudes. Some previous open areas (red & green) become closed (yellow), and field line connections change.

Early MURI Results

Adaptive Mesh MHD Modeling at Michigan

GENERATION OF A CORONAL MASS EJECTION (CME) BY FLUX-ROPE ERUPTION





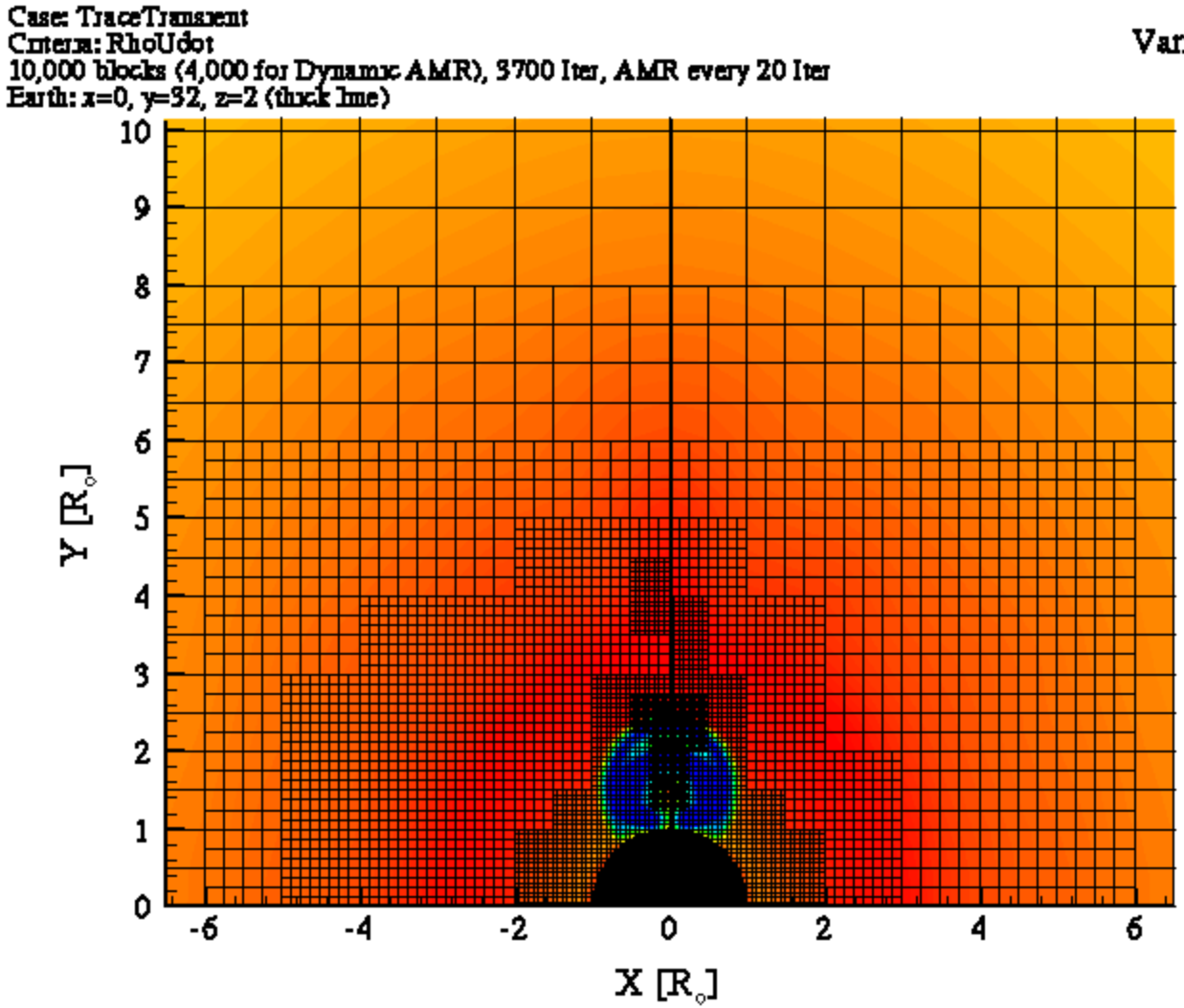
At t=0, the Gibson-Low (1998) analytic expression for an erupting flux rope is superimposed on a 3D quiet solar wind solution. The interaction of the flux eruption with the background solar wind is calculated with BATSRUS. At t=4hr, the CME expanded to ~25 solar radii (25 R_S) and propagated with superalfvenic speed in the background plasma. By this time, the driving plasma "piston" formed a shock, a magnetic loop, and a density cavity.

Early MURI Results

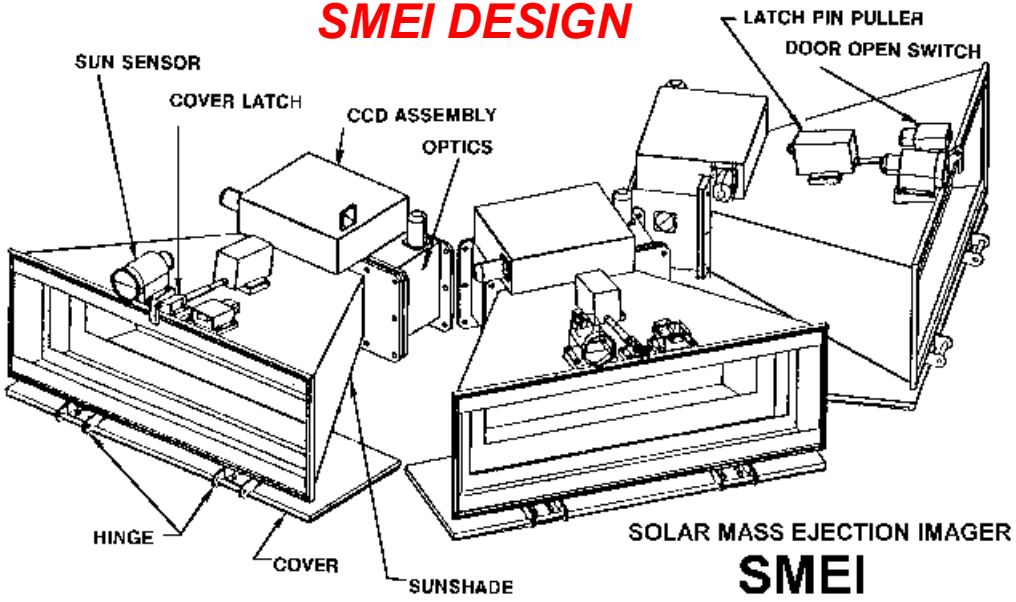
Adaptive Mesh MHD Modeling at Michigan

SIMULATION OF A CME

Click on image to begin animation



AFRL/VSB & AFOSR Fund SMEI
(Solar Mass Ejection Imager)



- SMEI will image the entire sky in white light once per spacecraft orbit, using baffled camera components with charge couple device (CCD) sensors.
- By tracking CMEs from the Sun to Earth, SMEI will make possible accurate 24- to 72-hour forecasts of geomagnetic storms
- SMEI will be launched into a sun-synchronous (830 km) orbit as part of the USAF Space Test Program's Coriolis Mission in 2003

NSF Science & Technology Center Enabled by AFOSR

Description

Partnering, Results, & Transitions

Future Trends

http://www.bu.edu/cism

World Institute for Space Environment Research (WISER)

Description

Partnering, Results, & Transitions

Future Trends

http://www.physics.adelaide.edu.au/wiser/

WISER, with HQ at Adelaide University in South Australia, is an international network of Centers of Excellence in space physics. WISER promotes collaboration in cutting-edge space environment research and in training of first-rate space scientists. Emphasis is placed on theoretical and computational studies of space plasmas and atmospheres, space data analysis, space weather forecasting, and monitoring the impact of space weather on the Earth's environment and technology. WISER is seeking UN sponsorship, similar to that received by the famed Abdus Salam International Centre for Theoretical Physics in Trieste, Italy.

Future AFOSR Solar Physics Activity

- Continue reaching out to foreign partners and leveraging the space weather research programs of Europe and the Pacific Rim
  - ➢ *The European Space Agency is trying to follow US footsteps in space weather forecasting, large investments are being made*
  - ➢ *Australia, Japan, Taiwan and other countries are taking the lead in space research in the Pacific, with Australia proposing a "World Institute for Space Environment Research (WISER)"*
- Support the development of the US Advanced Technology Solar Telescope (ATST), the replacement for the National Solar Observatory and AFRL's Sacramento Peak Observatory
- Expand research in deep space surveillance at AEOS on Maui, to include advanced adaptive optics for the needs of the ATST
- Leverage the NSF's Center for Adaptive Optics at UC Santa Cruz and their new Center for Integrated Space Weather Modelling at Boston University to ensure the transition of next generation optical sensors and space environment models to operational forecasting