EXACT:
Experiment for X-Ray Characterization and Timing

Speaker

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Contributors

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Astrophysical Sources of High Energy Radiation

- Solar Eruptive Events
  - Solar Flares
  - Coronal Mass Ejections

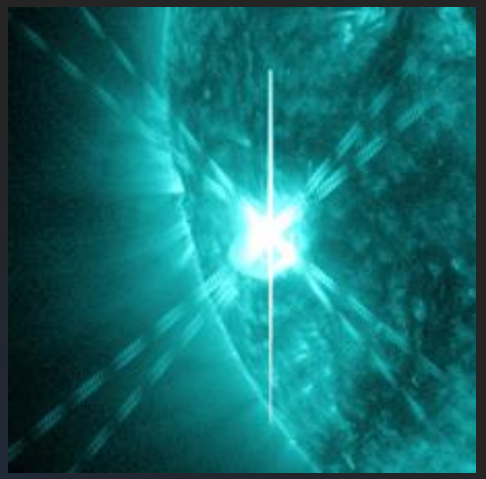
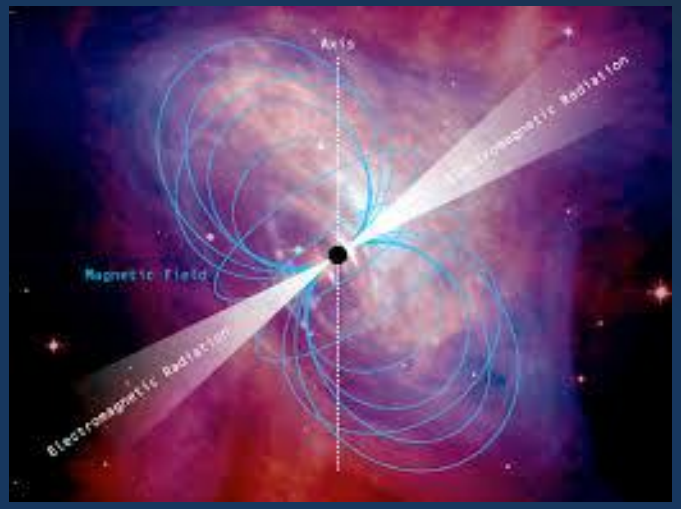


Figure 1: (Right) X-ray image of solar flare *(NASA).* (Left) Image of Pulsar (*NASA*)



- Non-Solar Astrophysical Radiation Sources
  - Gamma Ray Bursts
  - Pulsars

Solar Eruptive Events

- Solar Flares and Solar Cycle

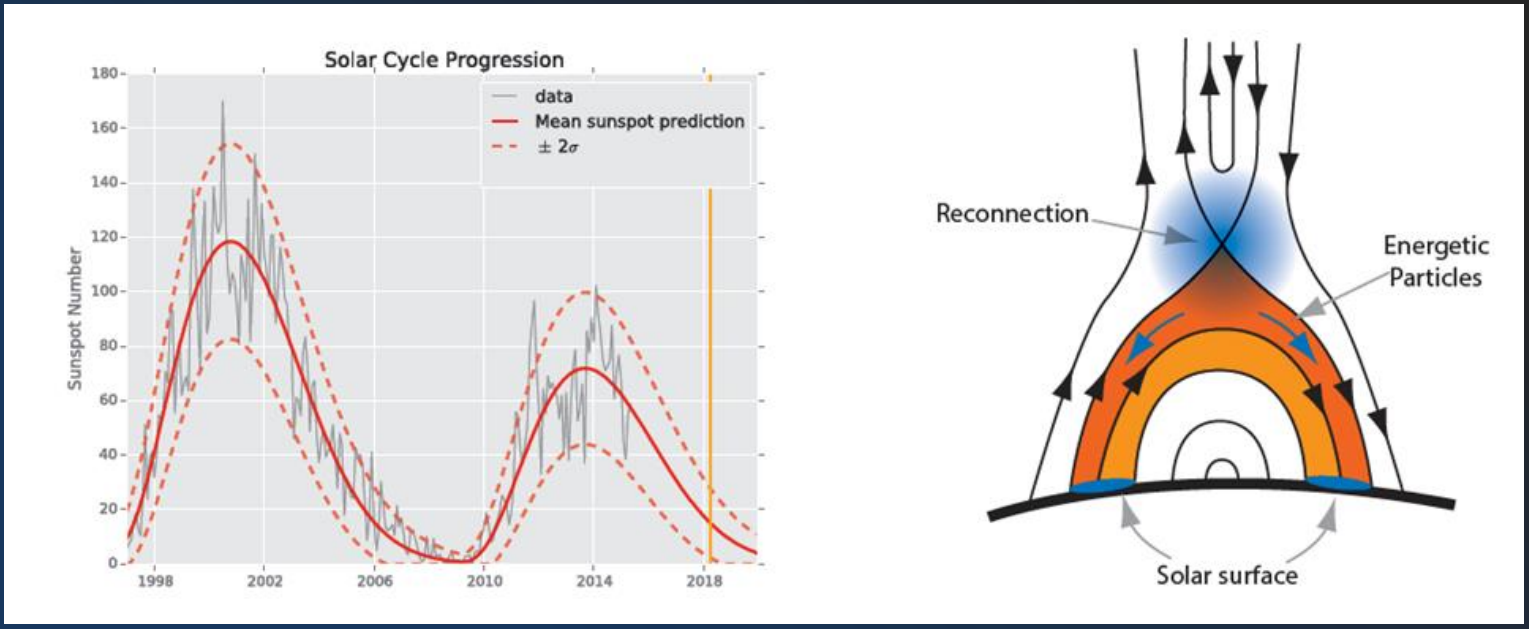


Figure 2: (Left) Sunspot numbers and flare activity in Solar Cycles 23 and 24. (Right) Standard Solar Flare Cartoon
*(*Both *Steven Christe, 2007)*

Solar Eruptive Events

- Coronal Mass Ejections (CME)

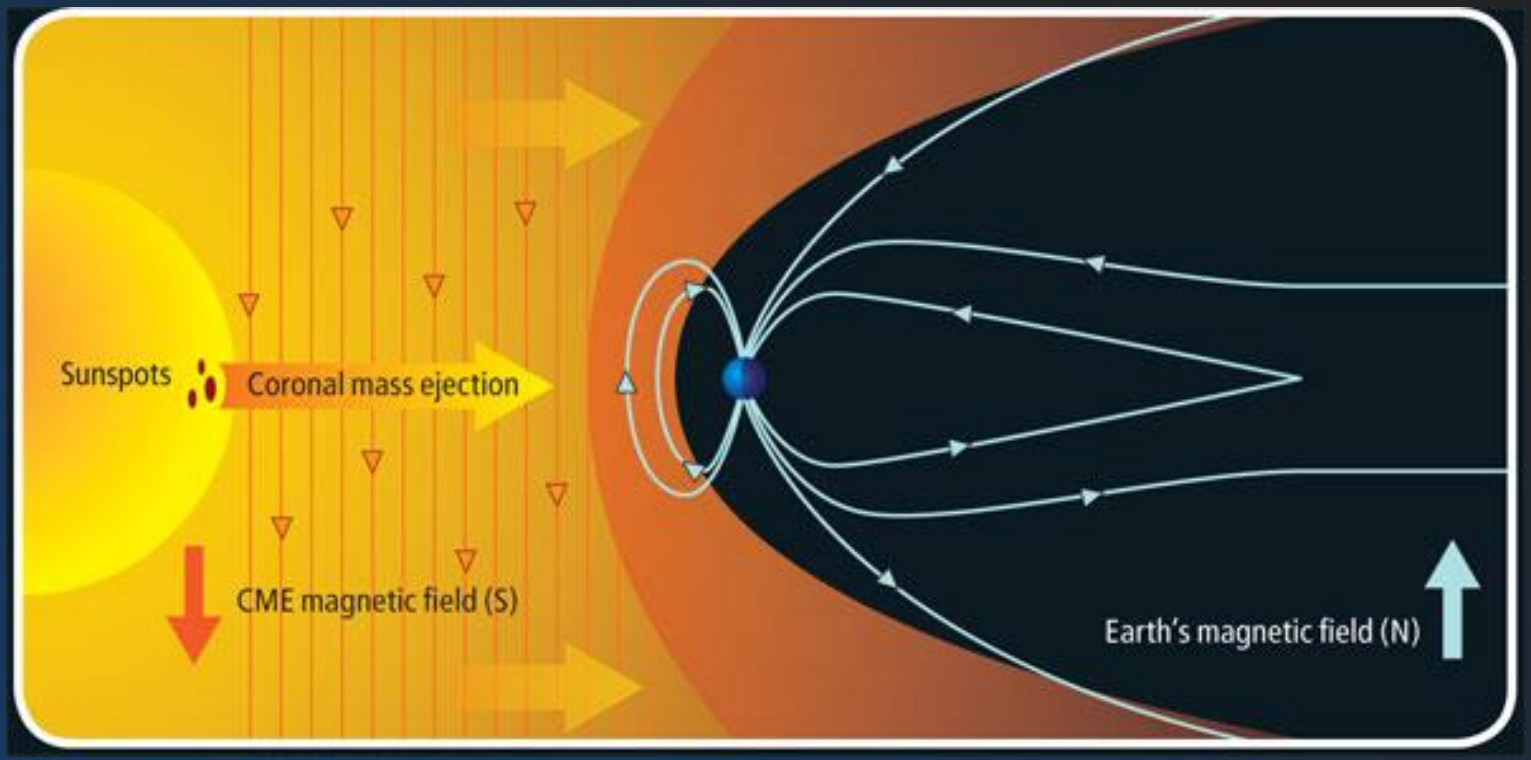


Figure 3: Coronal Mass Ejection and Earth's Magnetic Field *(thewatchers.adorraeli.com)*

Solar Eruptive Events: Still Unknown

- Energy Transfer
  - Magnetic fields to kinetic energy
  - Hard X-Ray signature
- Hard X-Ray Emission
  - Solar surface
  - Corona
  - CME cores

Navigation in Space

- Gamma Ray Bursts
  - Large, distant, high-energy EM events
- Pulsars
  - Periodic X-ray radiation source

- Precision timing of events
- Relative timing to give relative position
- Similar to GPS

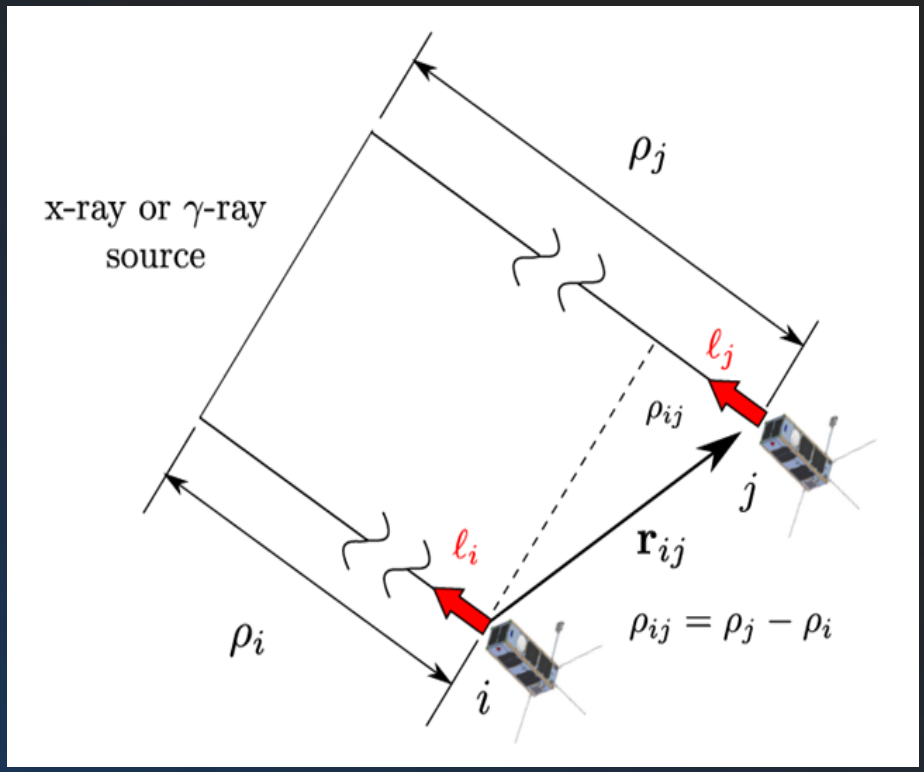


Figure 4: Determination of timing and position using X-Ray and Gamma Ray sources

EXACT: One Project, Two Missions

Shared Requirements:

- Energy ranges
- Timing requirements
- Sensor requirements

Shared Resources:

- Project funding
- Expertise and experience
- Two departments

Figure 5: UMN EXACT Project Logo

EXACT Team Structure

Aerospace Engineering (9)

- PI: Dr. Demoz Gebre Egziabher
- Sub-system design
- Component assembly and installation
- Spacecraft ranging

Space Physics (10)

- PI: Dr. Lindsay Glesener
- Solar activity research
- Detector testing and development
- Solar flare characterization

EXACT Team Structure

Undergrad Executive Team:

- Project Manager (PM)
- Chief Engineer (CE)
- Document Specialist

Senior Executive Team:

- Dr. Gebre and Dr. Glesener
- Executive PM
- Executive CE

The EXACT Satellite: GRID

- Gamma Ray Incidence Detector
  - Scintillator Detector with 4 CsI(Tl) crystals
  - Student designed
  - Inexpensive and replicable

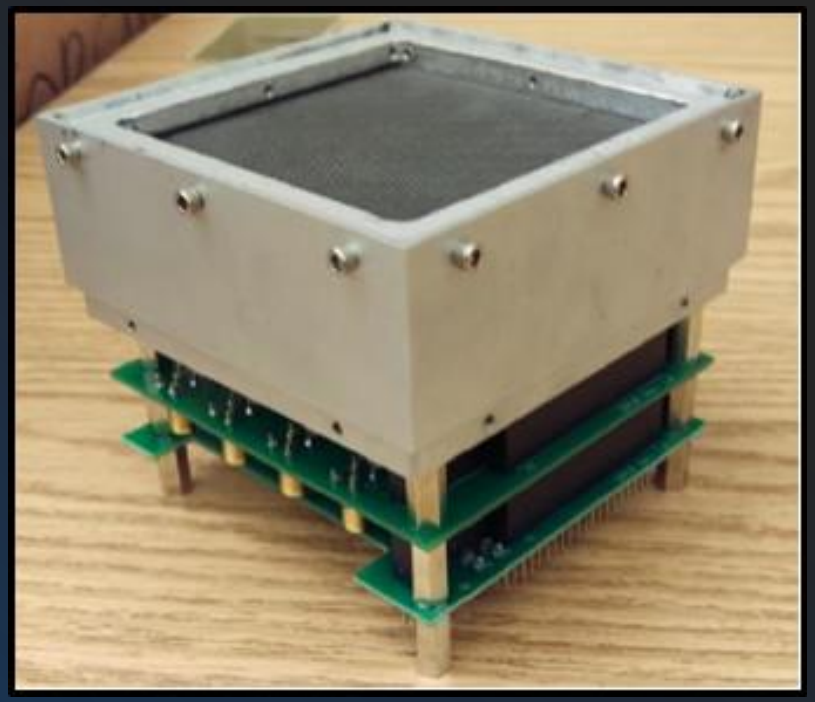


Figure 6: Image of GRID Detector

The EXACT Satellite: GRID

- GRID Detector
  - Redesign in progress
    - Time precision
    - Energy resolution
  - Continued Testing
    - At UMN
    - High Altitude Student Platform (HASP)

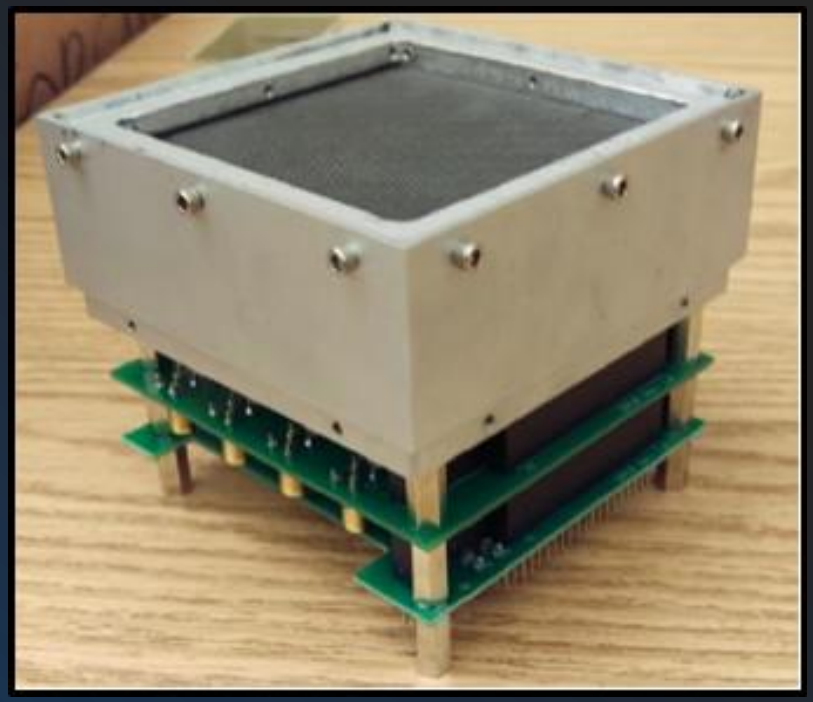


Figure 6: Image of GRID Detector

The EXACT Satellite: Sun-Pointing

- Solar Panels
  - Power generation
  - Attitude determination
- Magnetorquers
  - Attitude control

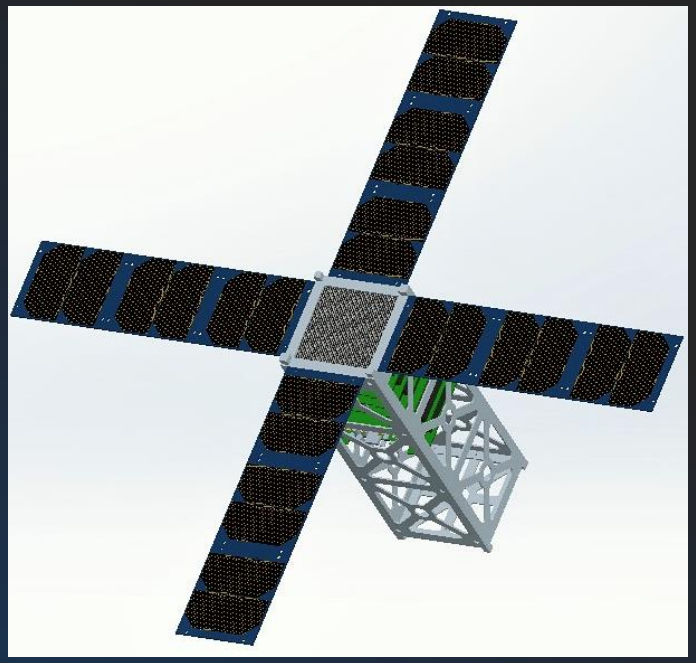


Figure 7: Image of EXACT with Solar Panels

EXACT Research and Testing

- Solar Flare Analysis
  - Predicted photon counts for each flare class
  - Used to predict data volume for detector

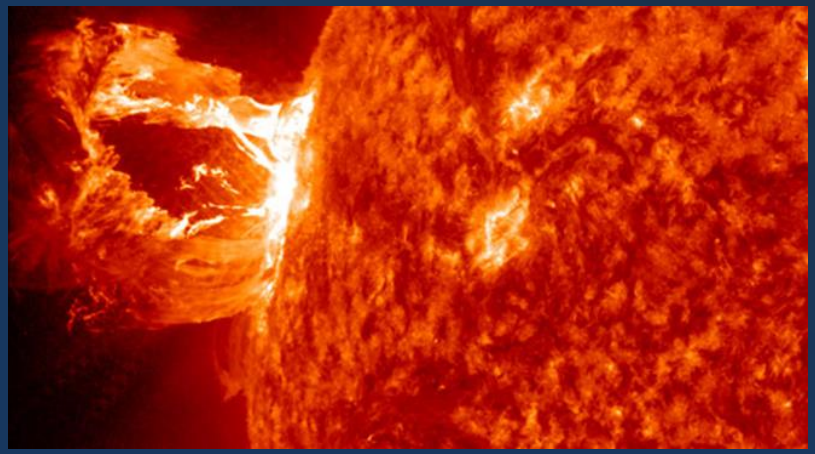


Figure 9: Image of Solar Flare (*NASA)*

Flare Class	Counts
B1	230,000
B5	935,000
B9	1,853,000
C1	3,370,000
C5	32,000,000
C9	58,000,000

Table 1: Solar flare counts by class

EXACT Research and Testing

- GRID Tests and Calibration
  - Testing with various radioactive sources
  - Discovered errors in current setup

Figure 10: Sample radioactive sources (*imagesco.com)*

EXACT Research and Testing

High Altitude Student Platform (HASP):

- Component Testbed
  - Detector
  - Communications
  - Power system
- Integration- August
- Flight- September

Figure 11: HASP Vehicle (*stratocat.com.ar)*

The Future and EXACT

- Inexpensive Hard X-Ray detector for solar observation
- Spacecraft ranging technique for positioning data in space
- Solar and space research at UMN