

# Our Dynamic Sun



Dr Helen Mason

University of  
Cambridge

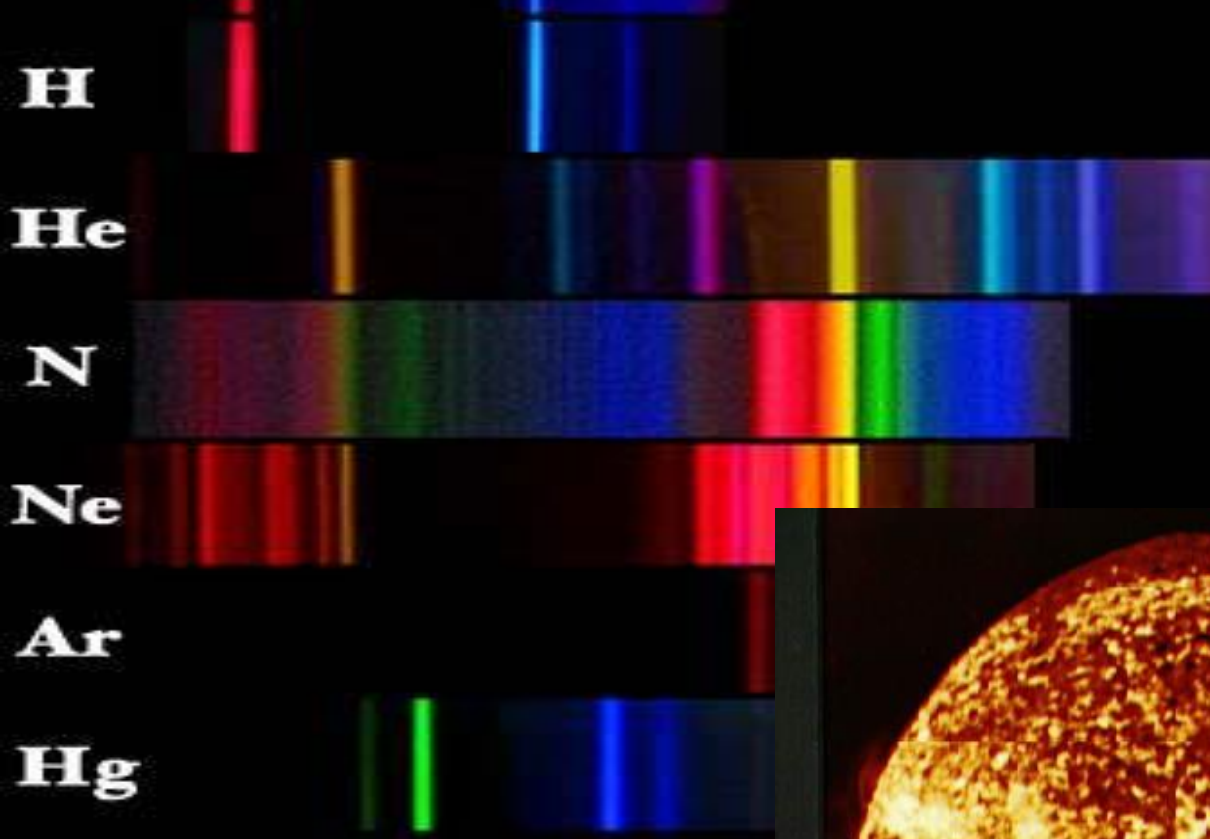
# Total Eclipse of the Sun



# PhD and Post-doc University College London

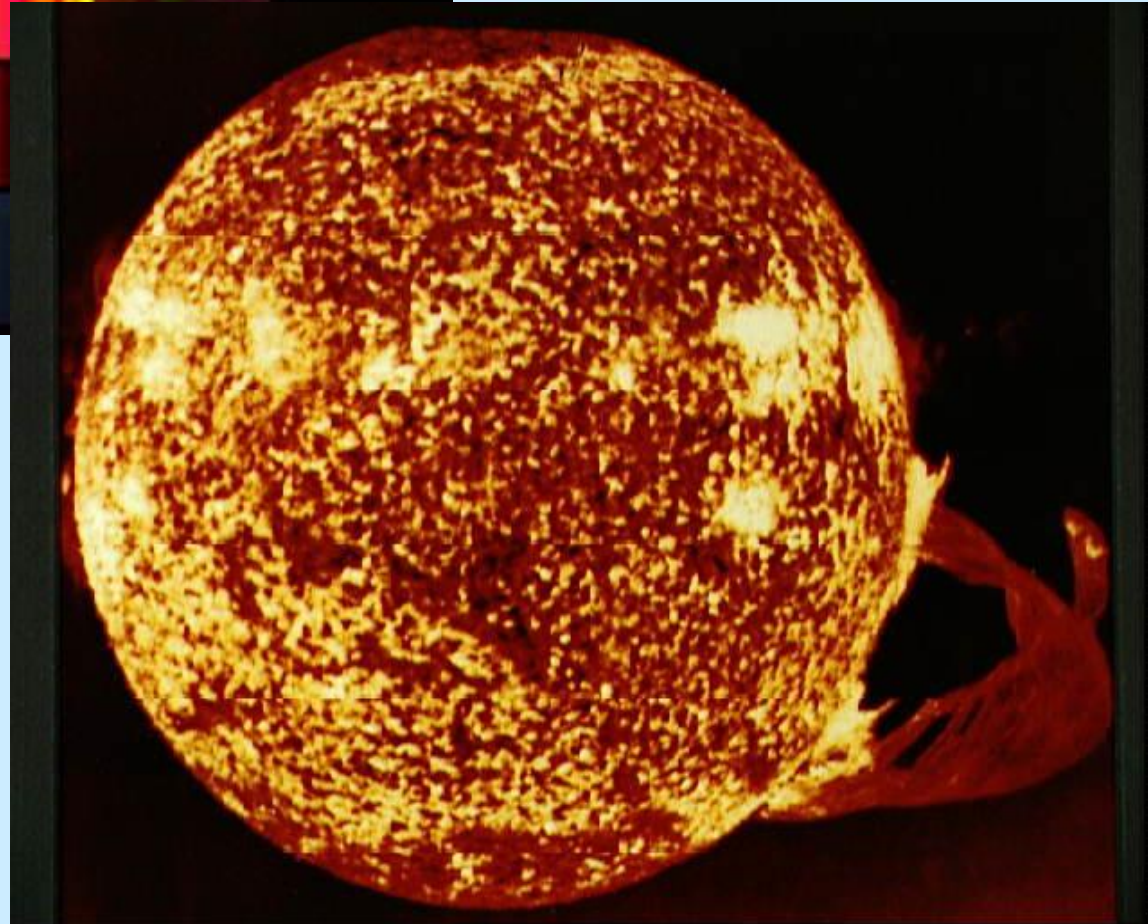


***Prof Mike Seaton and Dr Alan Burgess***



# Helium

*..was first  
discovered on the  
Sun*

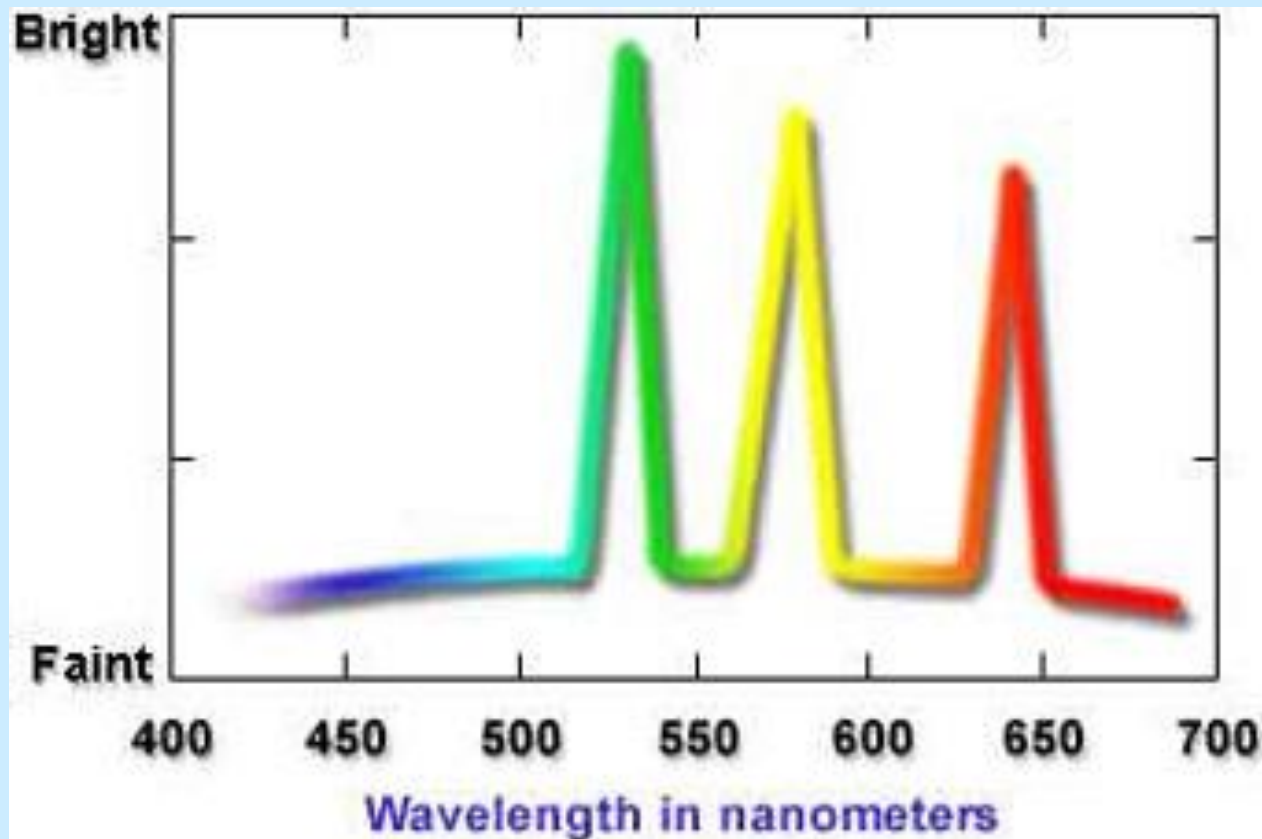


**Spectra from  
different  
elements....**

# Coronium..a new element??

..a mysterious spectral line was seen during a total solar eclipse - green line (530.3nm)

This was explained as a new element, coronium!!



**‘Coronium’ is just very hot iron**

**Iron normally has 26 electrons**

**At 1535C Iron melts...**

**at 2750C Iron becomes a gas**

**Sun’s surface is about 6,000C**

**Solar atmosphere (corona) is a whopping 1,000,000C !!!**

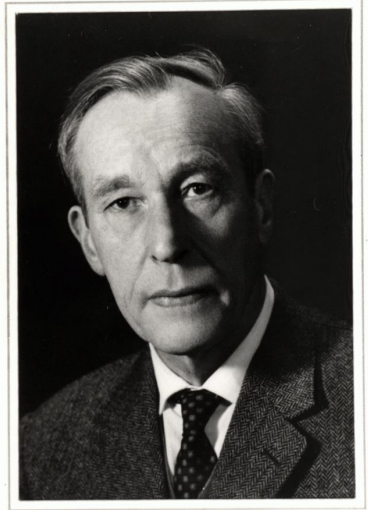
**As the temperature rises, electrons get ‘stripped off’.**

**By 1,000,000C, thirteen electrons have gone,**

**We call this Fe+13 or FeXIV**



# Visible coronal lines

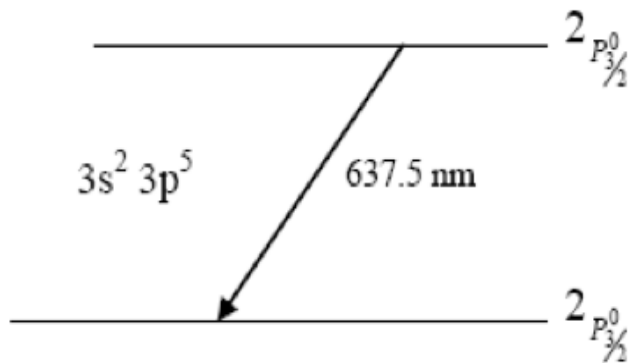


**Bengt Edlén (1943)**

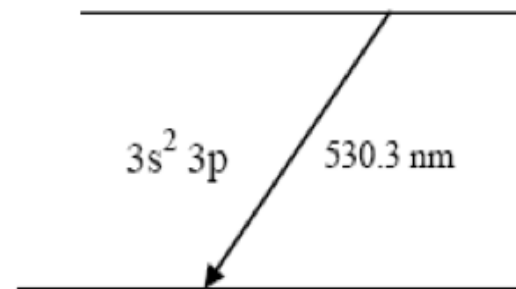
**Green coronal line (530.3 nm) from Fe<sup>+13</sup>.**

**Green (530.3 nm) & Red (637.5 nm) coronal lines →  
Forbidden lines in the spectra of Fe XIV (Fe<sup>+13</sup>) & Fe X (Fe<sup>+9</sup>)**

**Fe X 'Red' line**

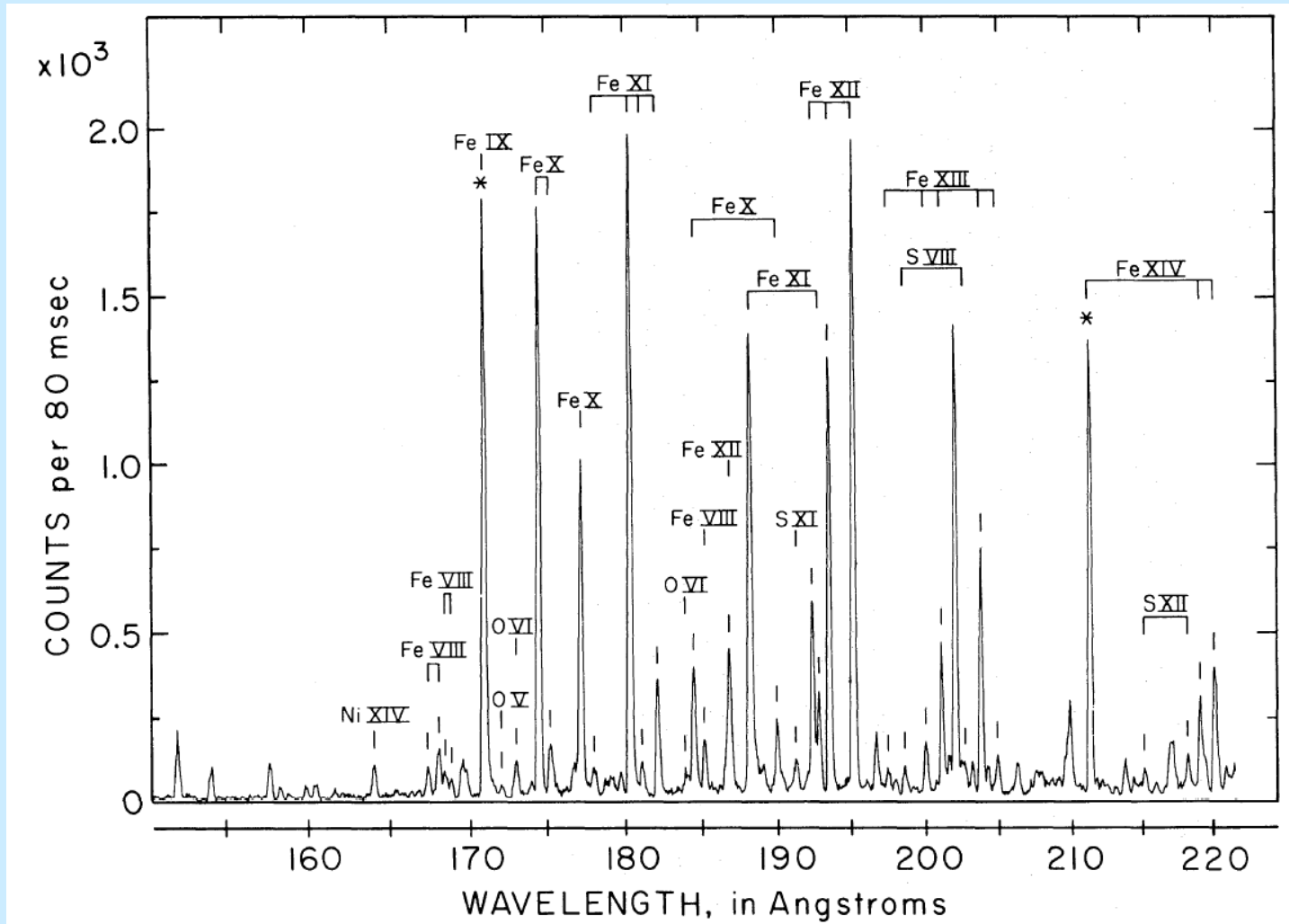


**Fe XIV 'Green' line**



**'Red' and 'Green' coronal lines.**

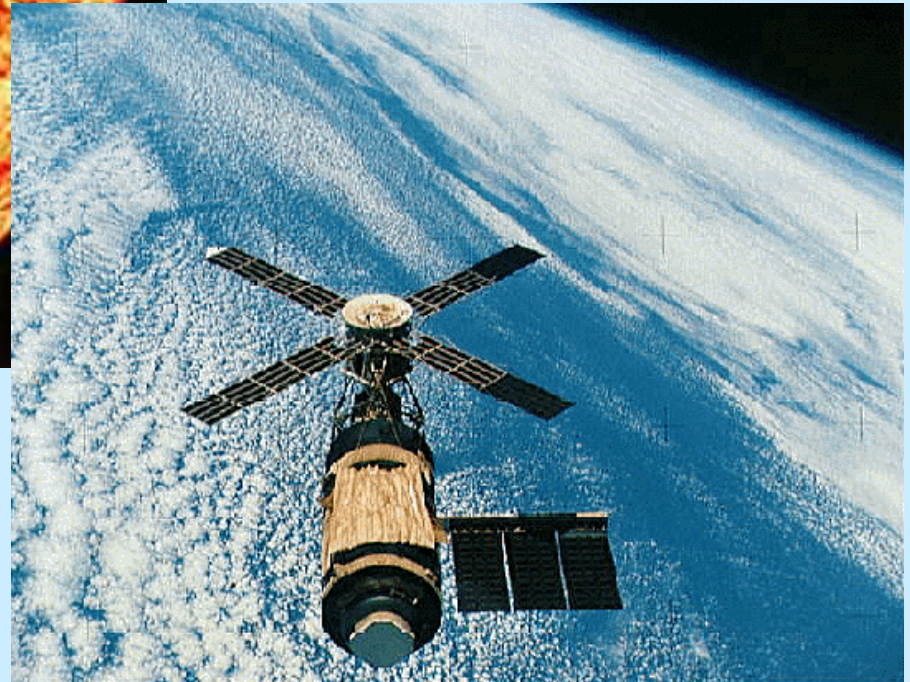
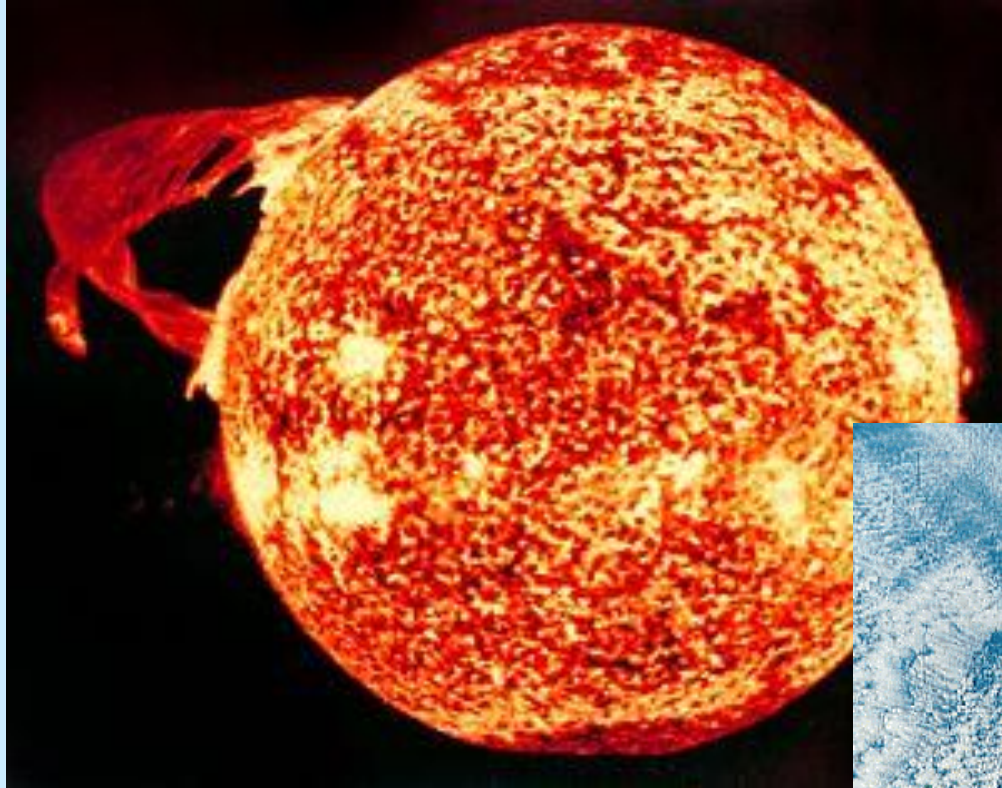
# Rocket Flights – 1970s



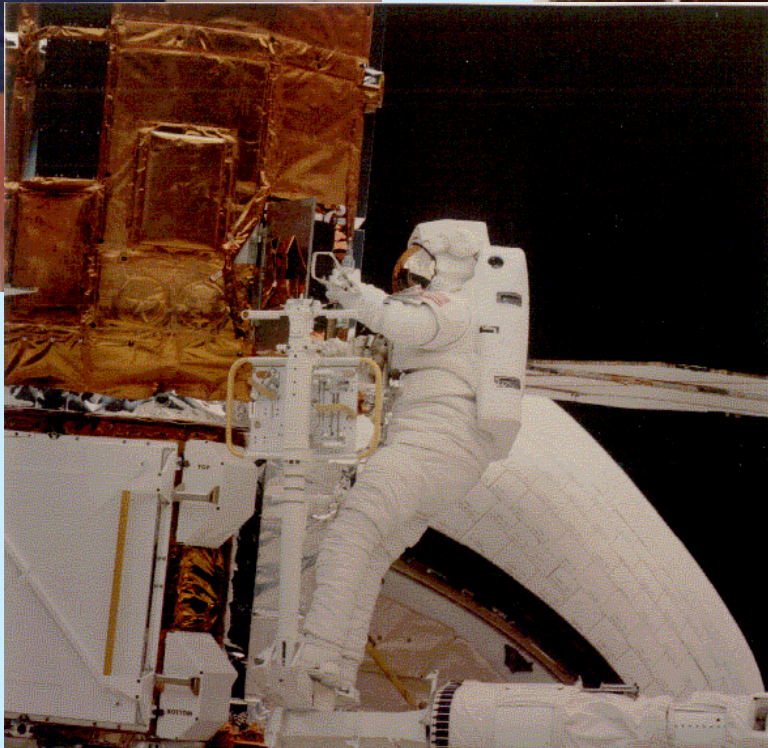
**Malinovsky & Heroux (1973)**



# Skylab Workshops – 1970's

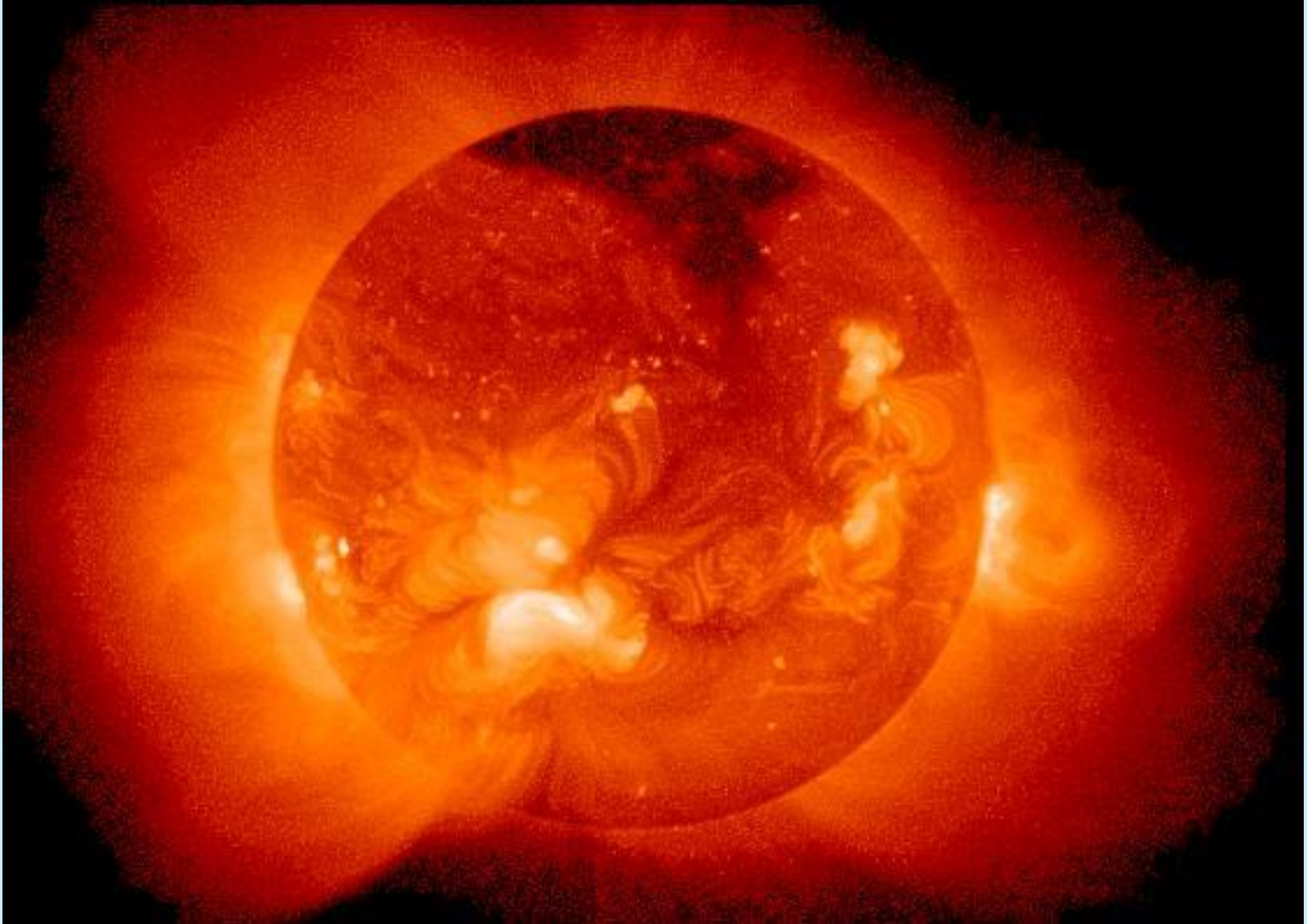


# Solar Maximum Mission Goddard Space Flight Center, 1980's

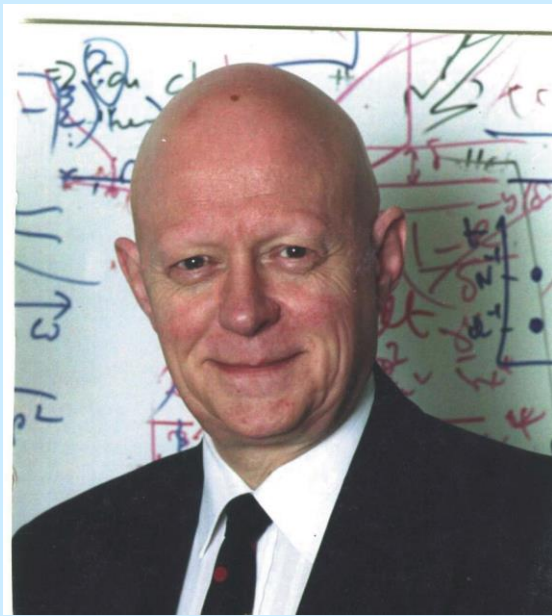


# **YOHKOH - the X-ray Sun**

## **More than one million degrees**



# DAMTP



**Prof David Crighton**



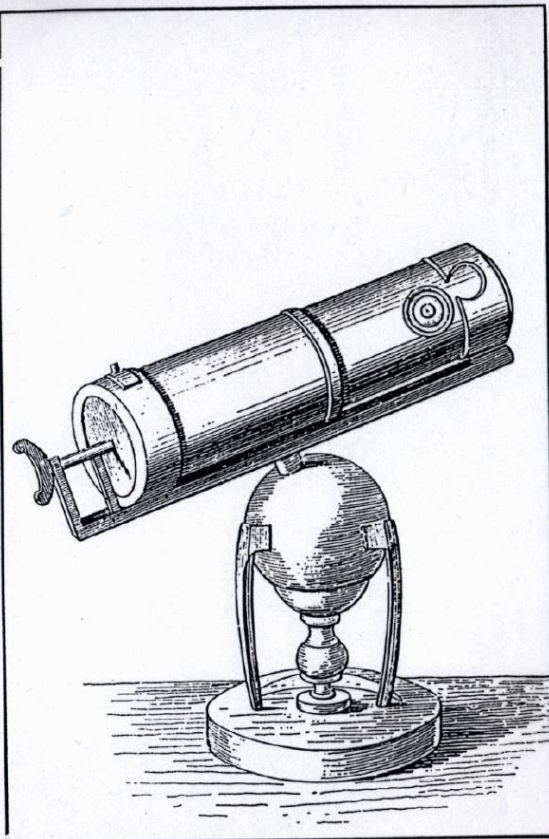
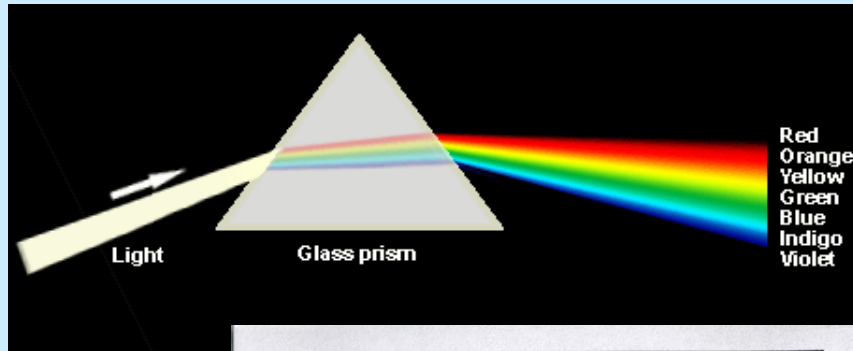
# University of Cambridge



- Tradition
- Excellence
- Responsibility
- Beauty
- Networking
- DAMTP/faculty
- St Edmund's College  
(Tutor/Senior Tutor)

# Sir Isaac Newton

1642 - 1727



**OPTICKS:**  
OR, A  
**TREATISE**  
OF THE  
REFLEXIONS, REFRACTIONS,  
INFLEXIONS and COLOURS  
OF  
**L I G H T.**  
ALSO  
**Two TREATISES**  
OF THE  
SPECIES and MAGNITUDE  
OF  
**Curvilinear Figures.**

LONDON,  
Printed for SAM. SMITH, and BENJ. WALFORD,  
Printers to the Royal Society, at the *Printers Arms* in  
St. Paul's Church-yard. MDCCIV.

*Sir* ISAAC NEWTON'S  
PHILOSOPHY

Explain'd

For the Use of the LADIES.

In SIX DIALOGUES

ON

LIGHT and COLOURS.

From the *Italian* of Sig. *Algarotti*.

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VOLUME I.

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*Quæ legat ipsa Lycoris.* VIRG. EC. X.

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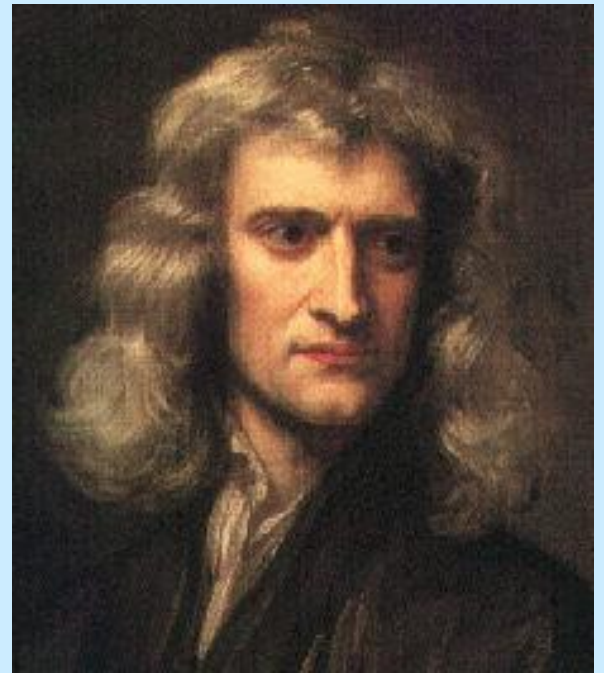
LONDON:

Printed for E. CAVE, at St. John's-Gate,  
MDCCXXXIX.



**Sir Isaac Newton**

**Trinity College, Cambridge**

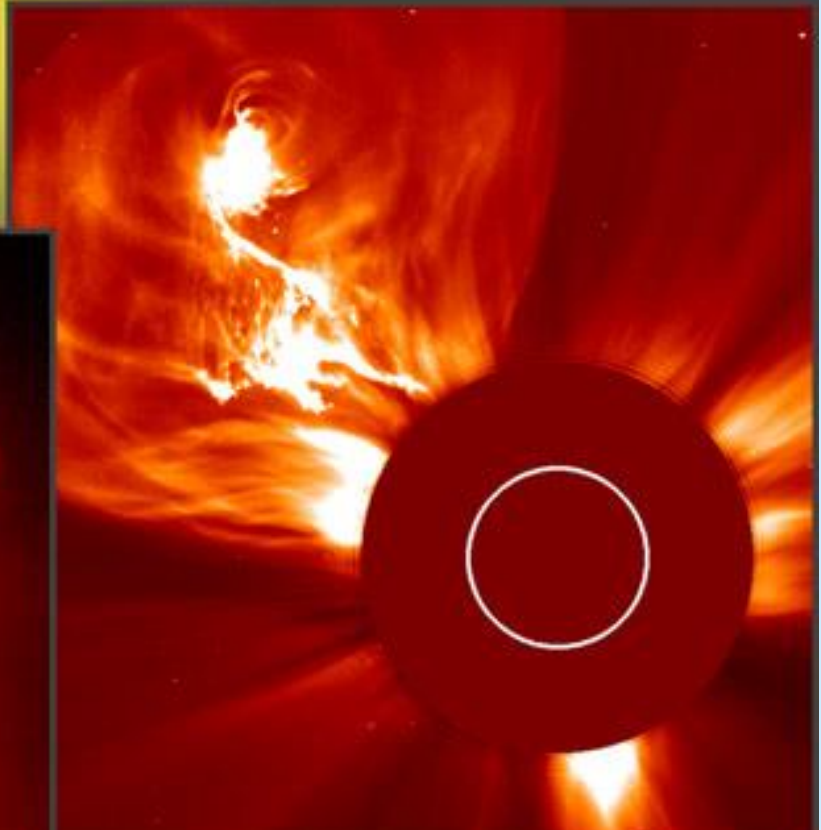
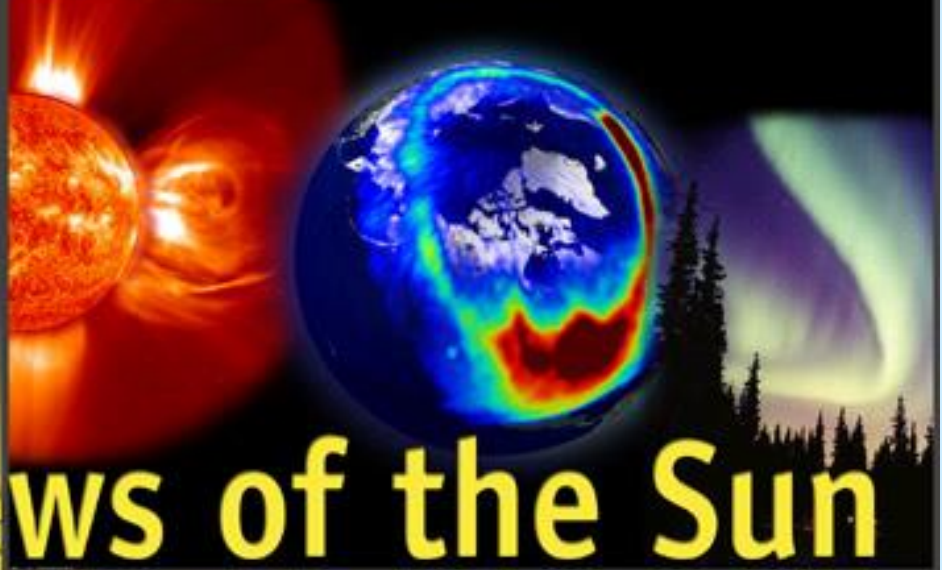


**“I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.”**

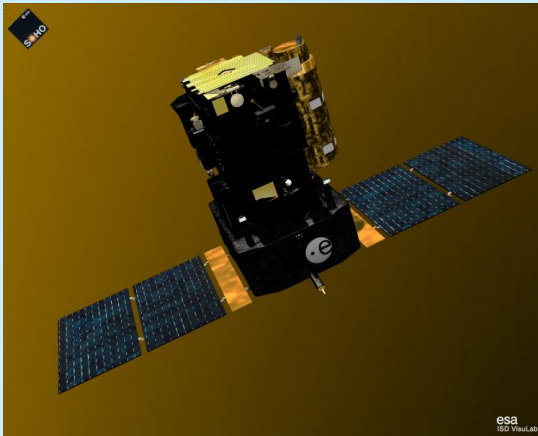


**SOHO**

**New Views of the Sun**

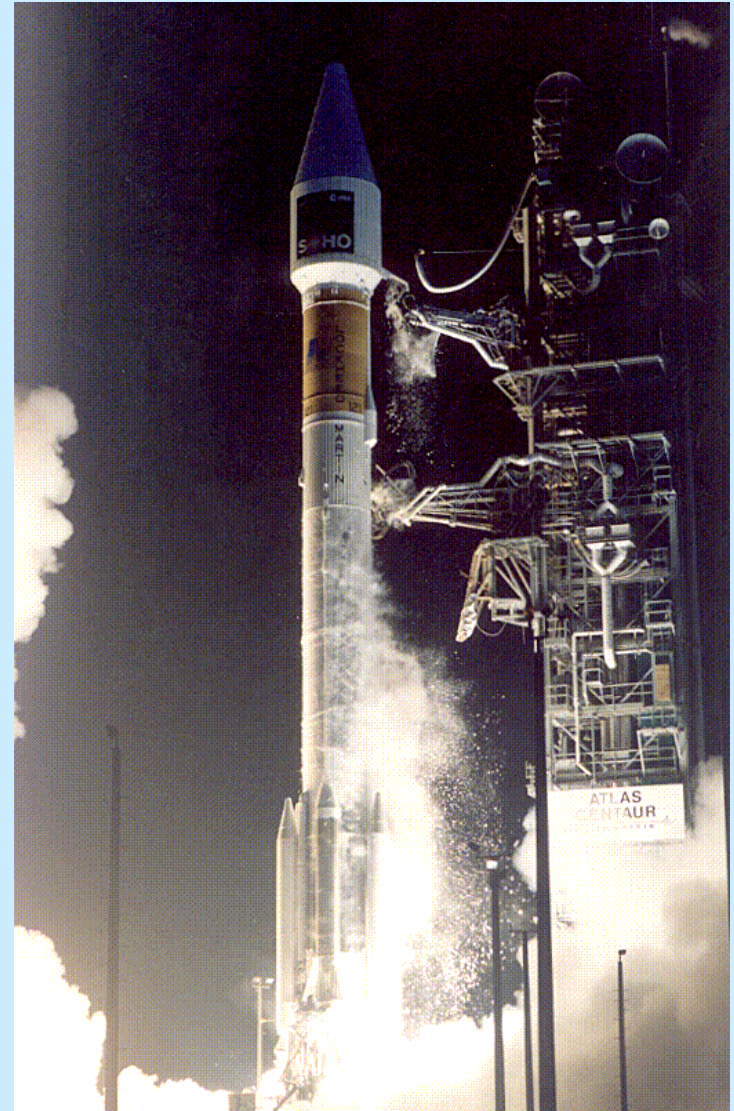


# What is SOHO?



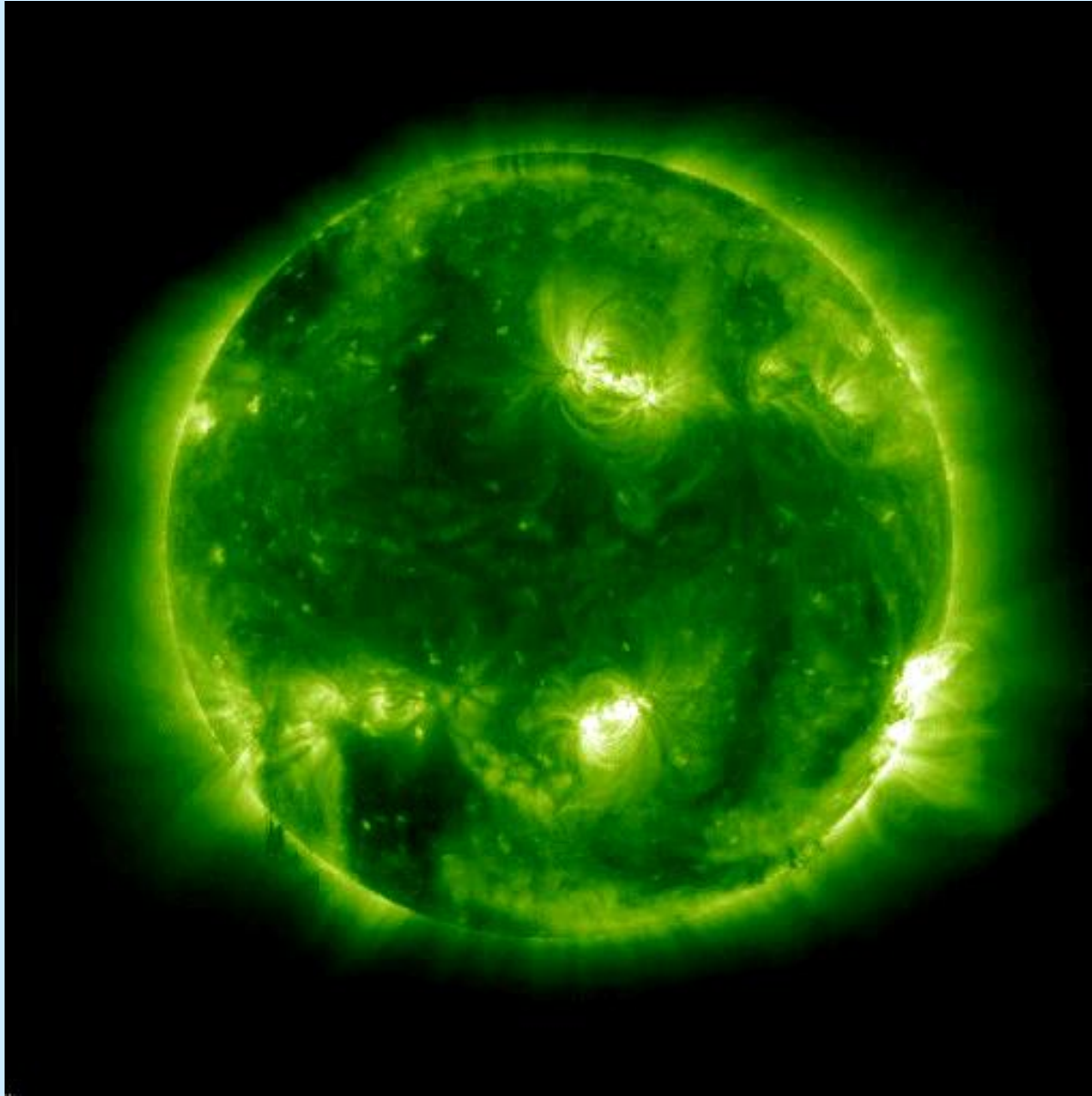
## Solar and Heliospheric Observatory

- The most sophisticated solar observatory ever built!
- ESA / NASA
- launched - 2 Dec 1995
- 12 instruments to study:
  - solar interior
  - solar atmosphere
  - solar wind



# SOHO – EIT - the UV Sun

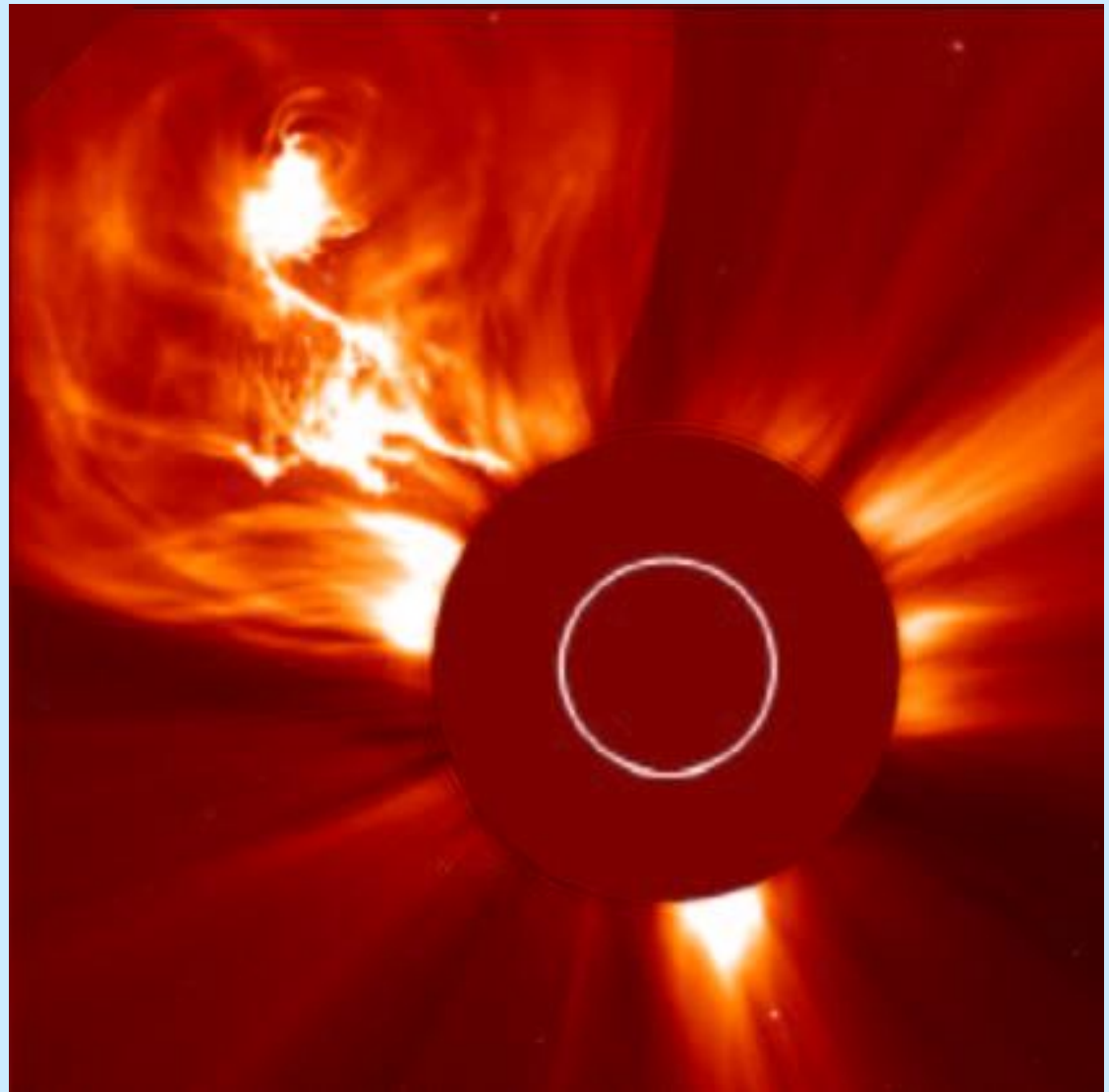
The solar corona is very hot, over one million degrees!!

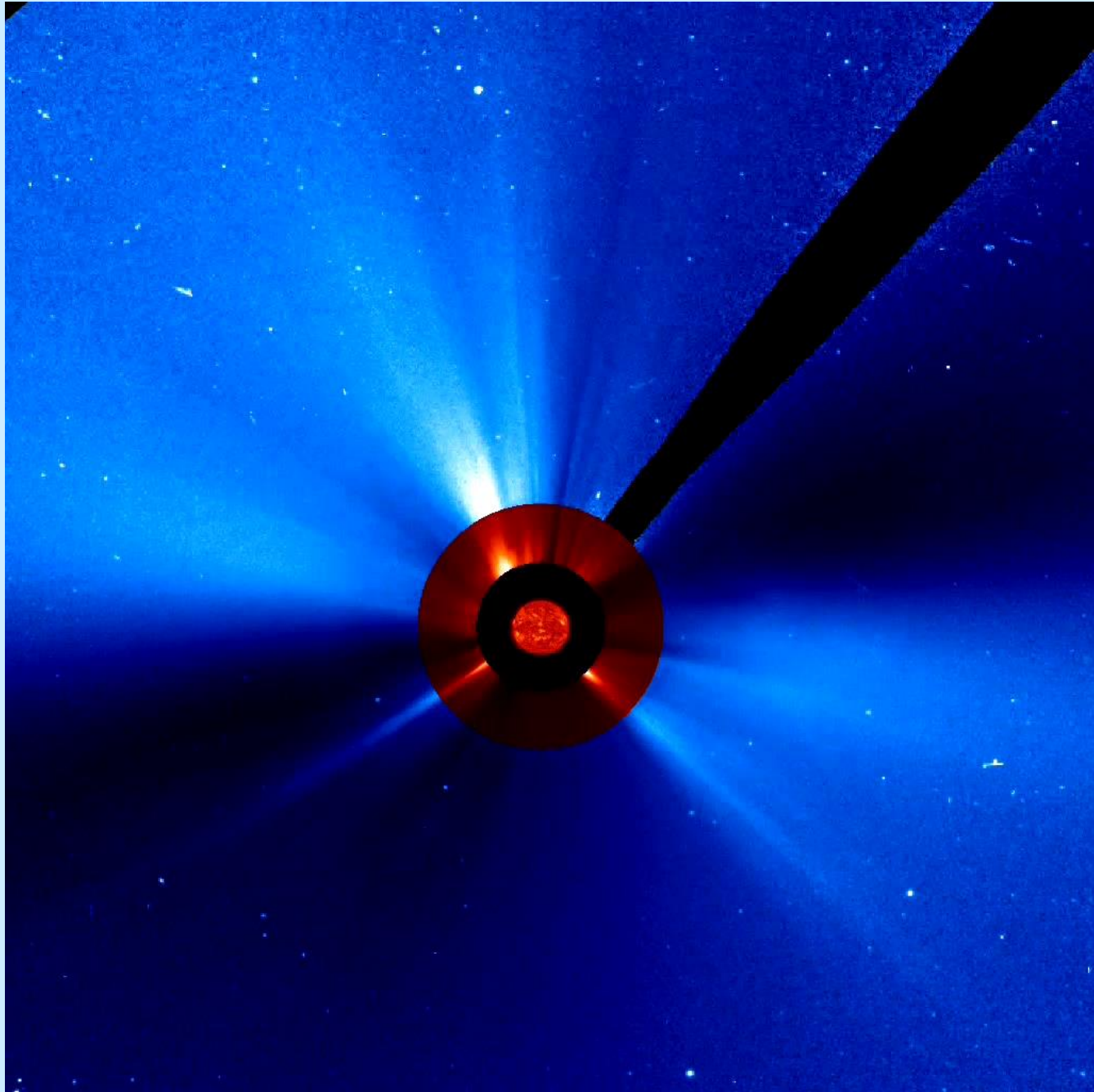


# SOHO – LASCO

## Coronal Mass Ejections (CME's)

1,000,000,000  
tonnes of material  
moving with  
speeds of up to  
2000 km/s



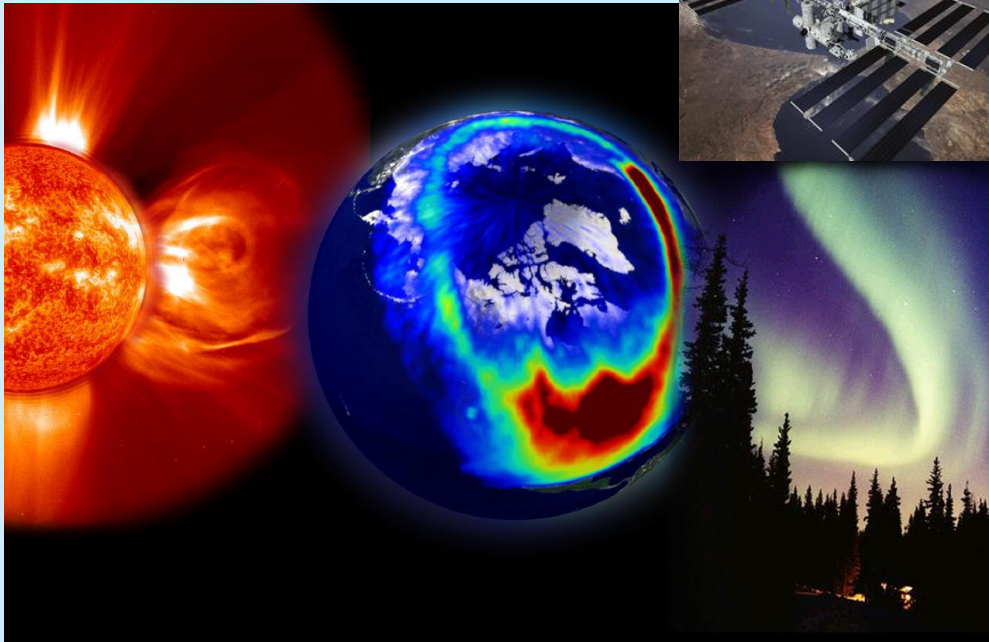


# The Sun-Earth Connection

Disruption of technology based systems

Harm humans in space

Aurora



# Hinode

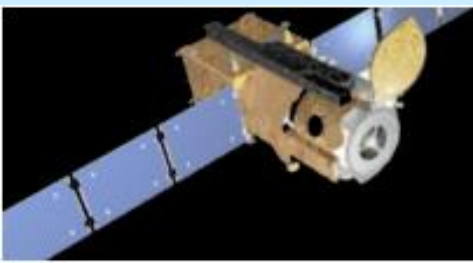
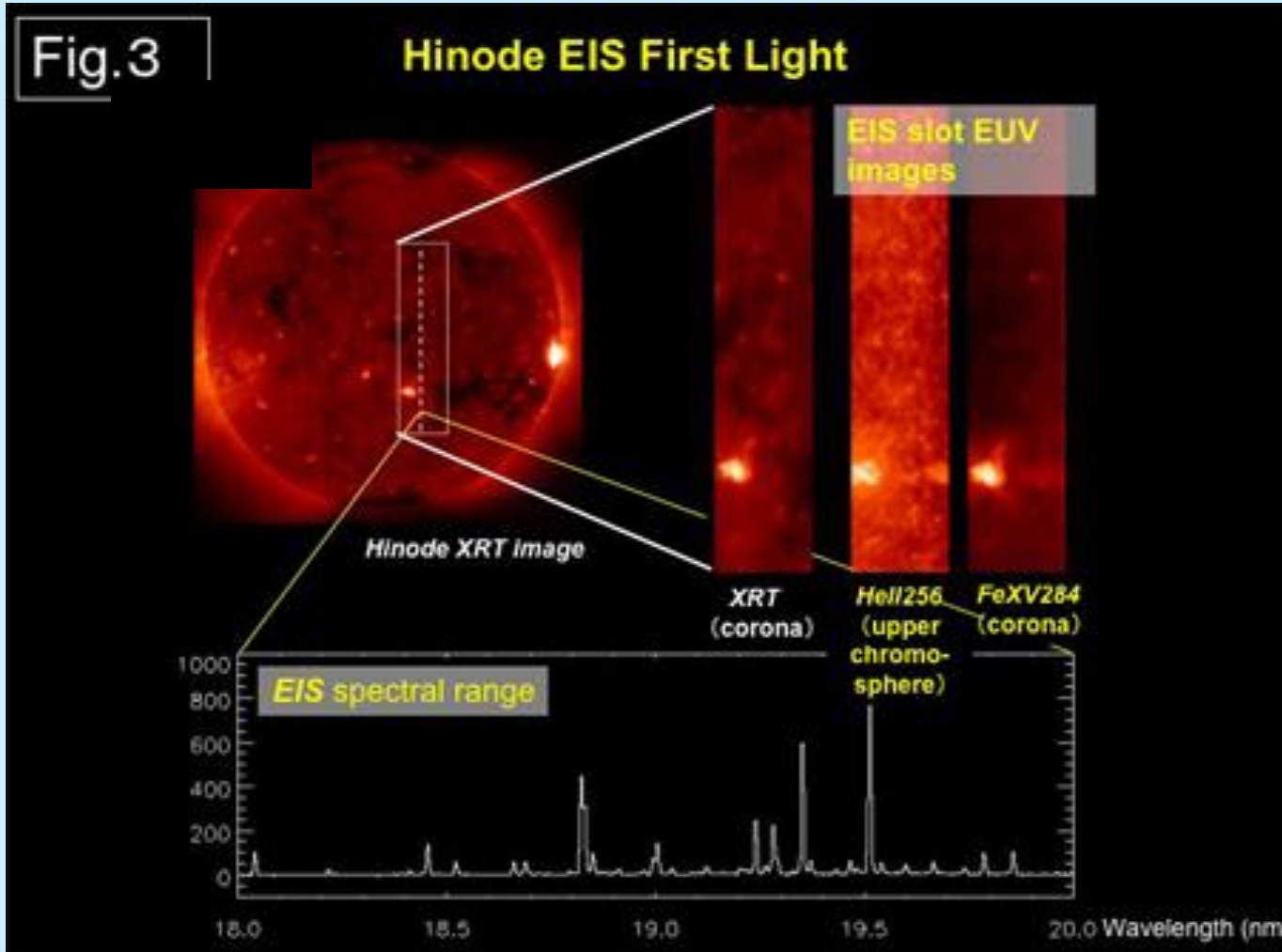
- **Japan/USA/UK mission**
- **3 scientific instruments**
  - **X-ray imager (XRT)**
  - **EUV spectrometer (EIS)**
  - **Optical telescope (SOT)**
- **Launched 2006**



**Prof Louise Hara  
and colleagues  
MSSL, UCL**



# Hinode EIS



**Hinode**  
EIS



**UCL**

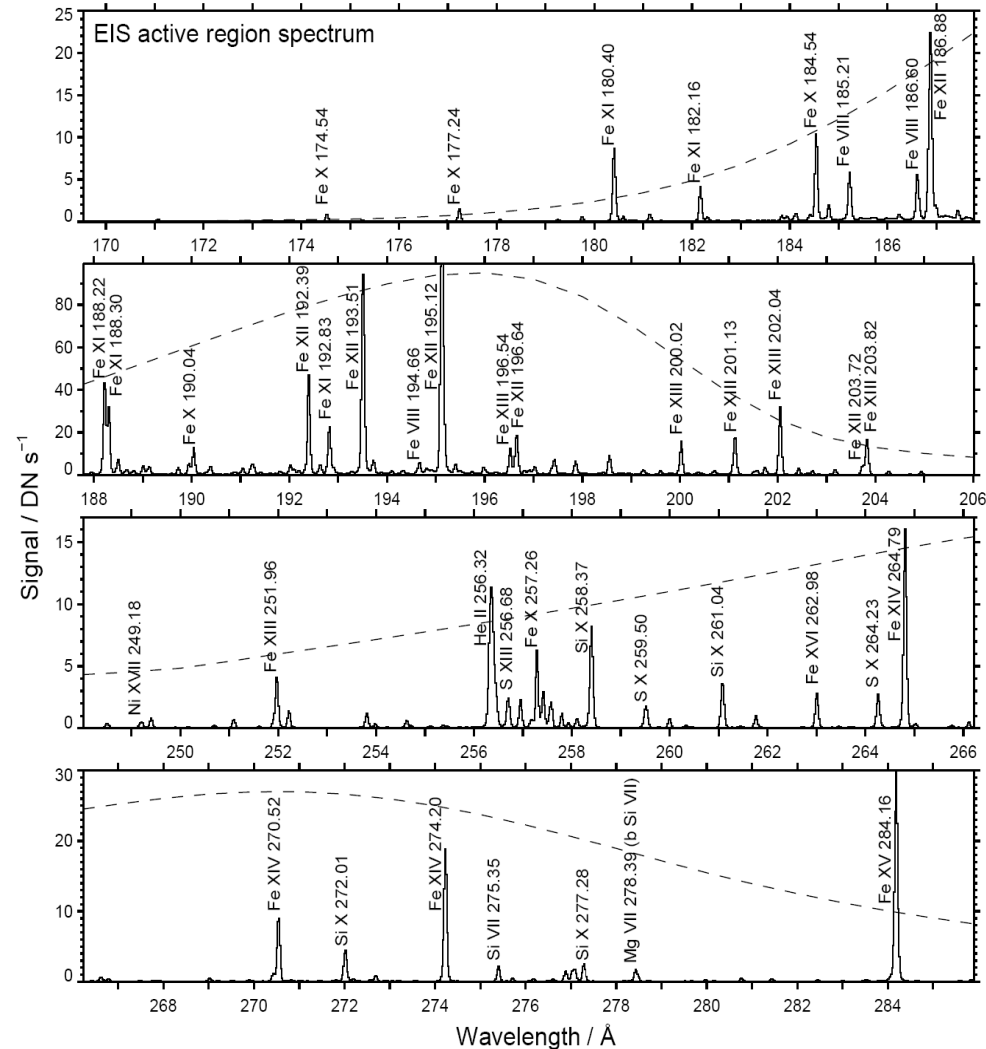


# CHIANTI

## An atomic database for astrophysics



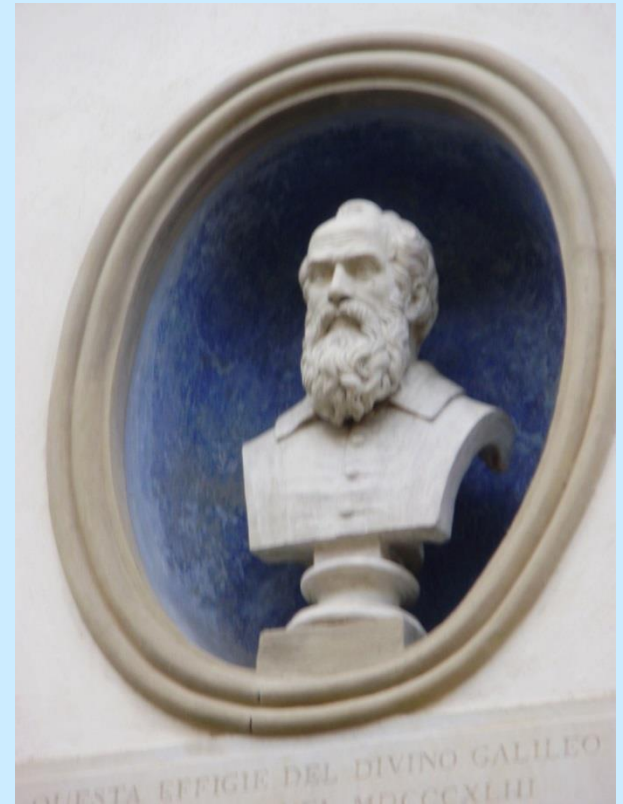
- UK, USA, Italy
- First released in 1996
- Just released v7.1, 2013
- Complete coverage in X-ray and EUV wavelength range
- Over 1,500 citation



A spectrum from Hinode/EIS

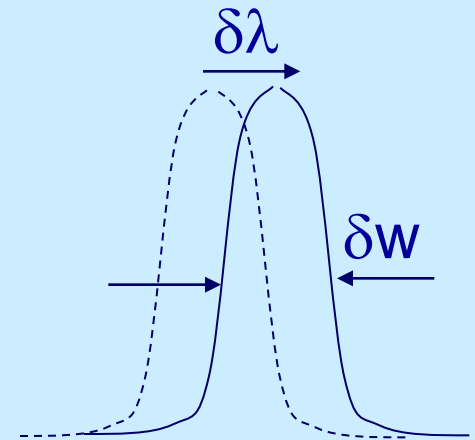
# Galilei Galileo

- You cannot teach a man anything, you can only help him discover it himself*

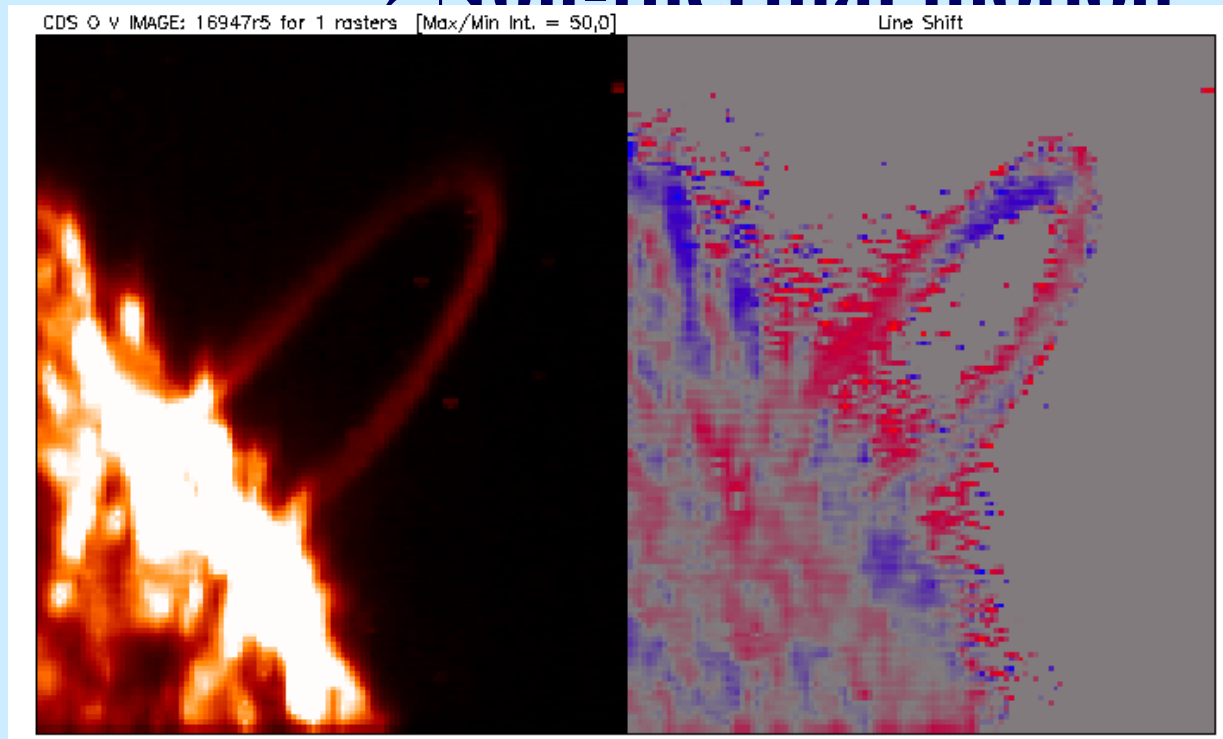


# Spectral Line Profiles

- Line intensity and profile
- Line shift ( $\delta\lambda$ )  $\rightarrow$  Doppler motion
- Line width ( $\delta w$ ) and temperature



$\rightarrow$  **Non-thermal motion**

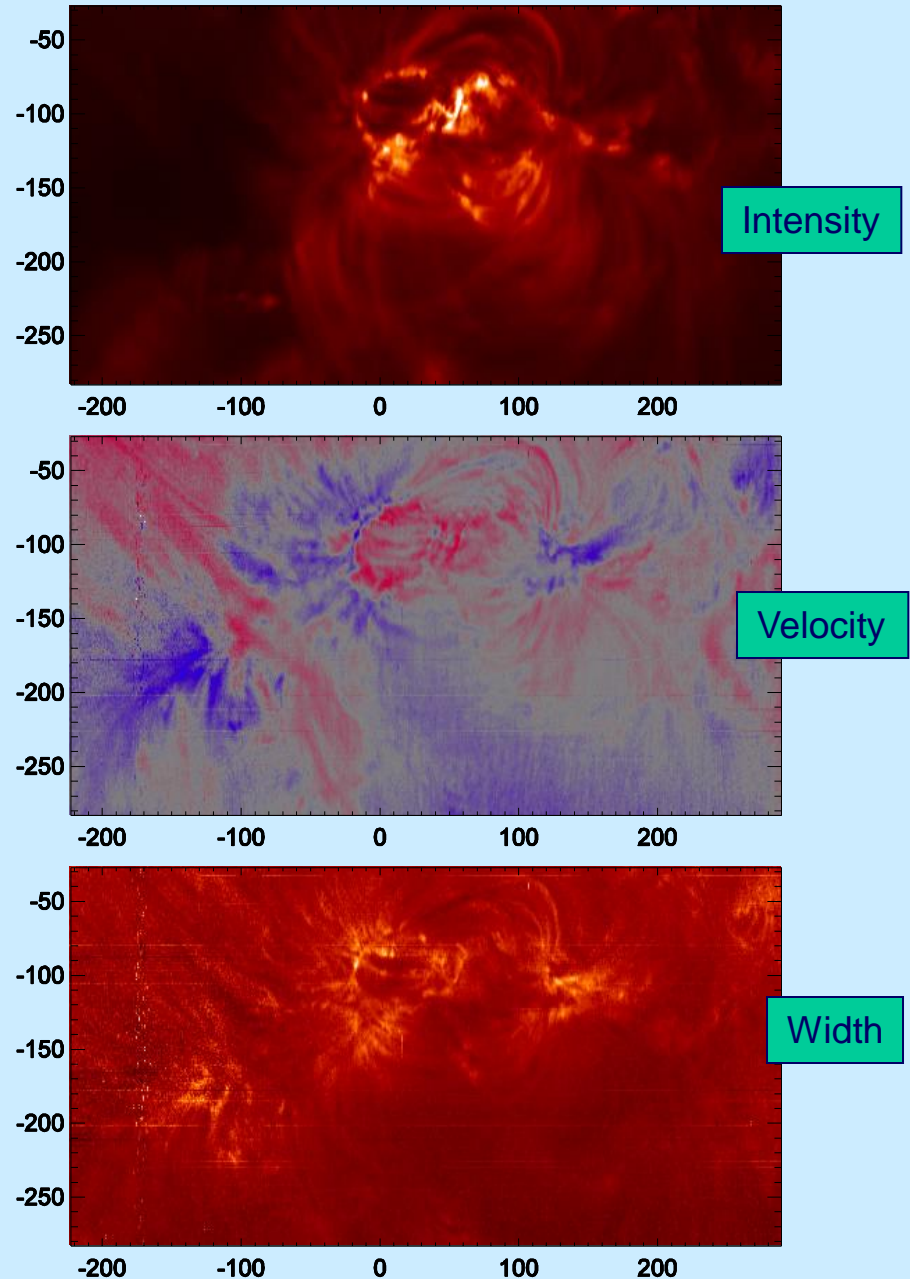


# Hinode/EIS: Intensity, velocity and line width maps

## Active region map in Fe XII 195.12 Å

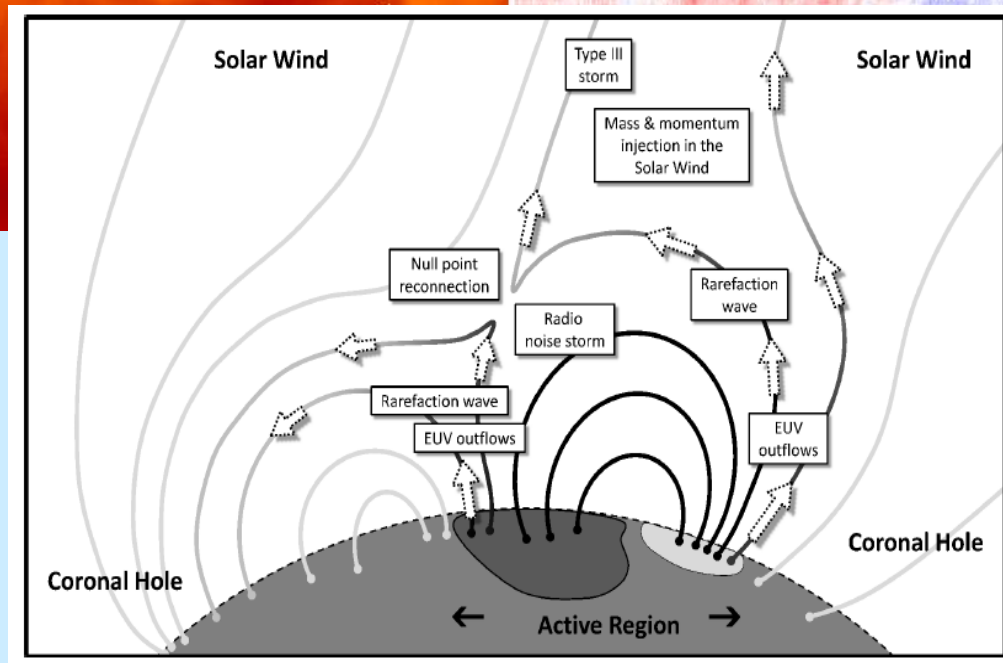
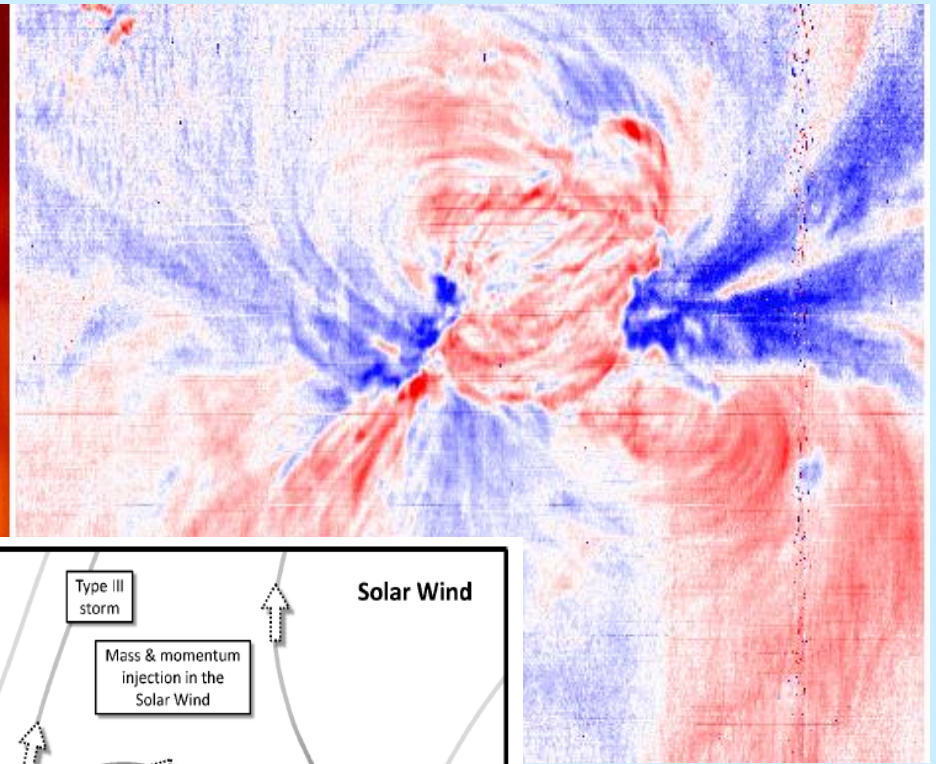
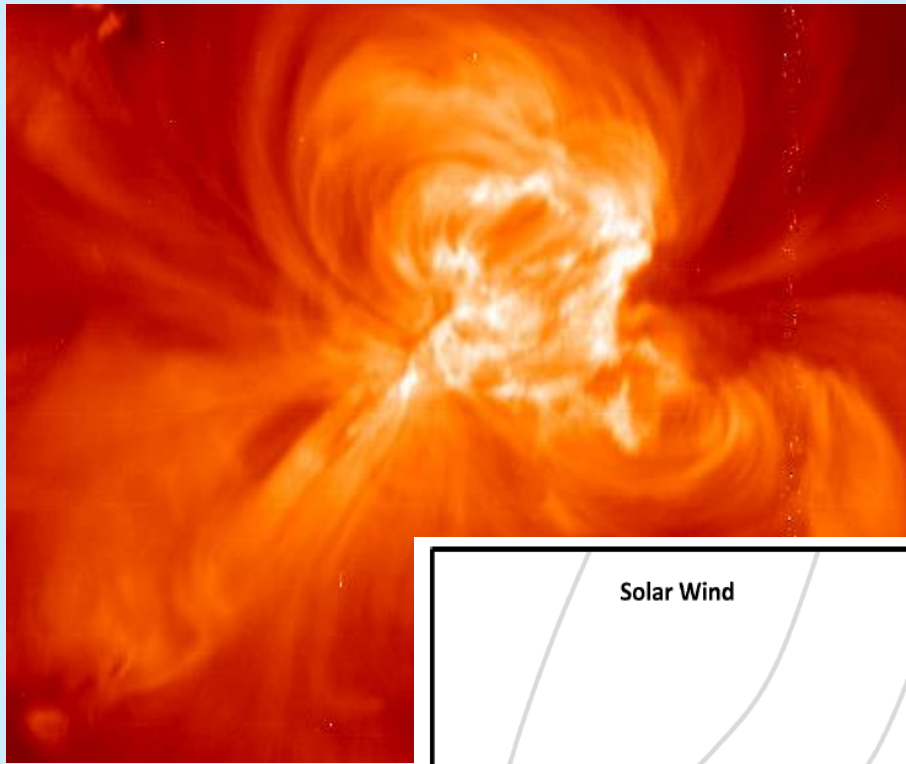
Hinode/EIS can provide detailed maps of electron density, temperature, flows, non-thermal broadenings, and fill factors.

One of the most striking features of Hinode EIS data for active regions are the blueshifts and redshifts.

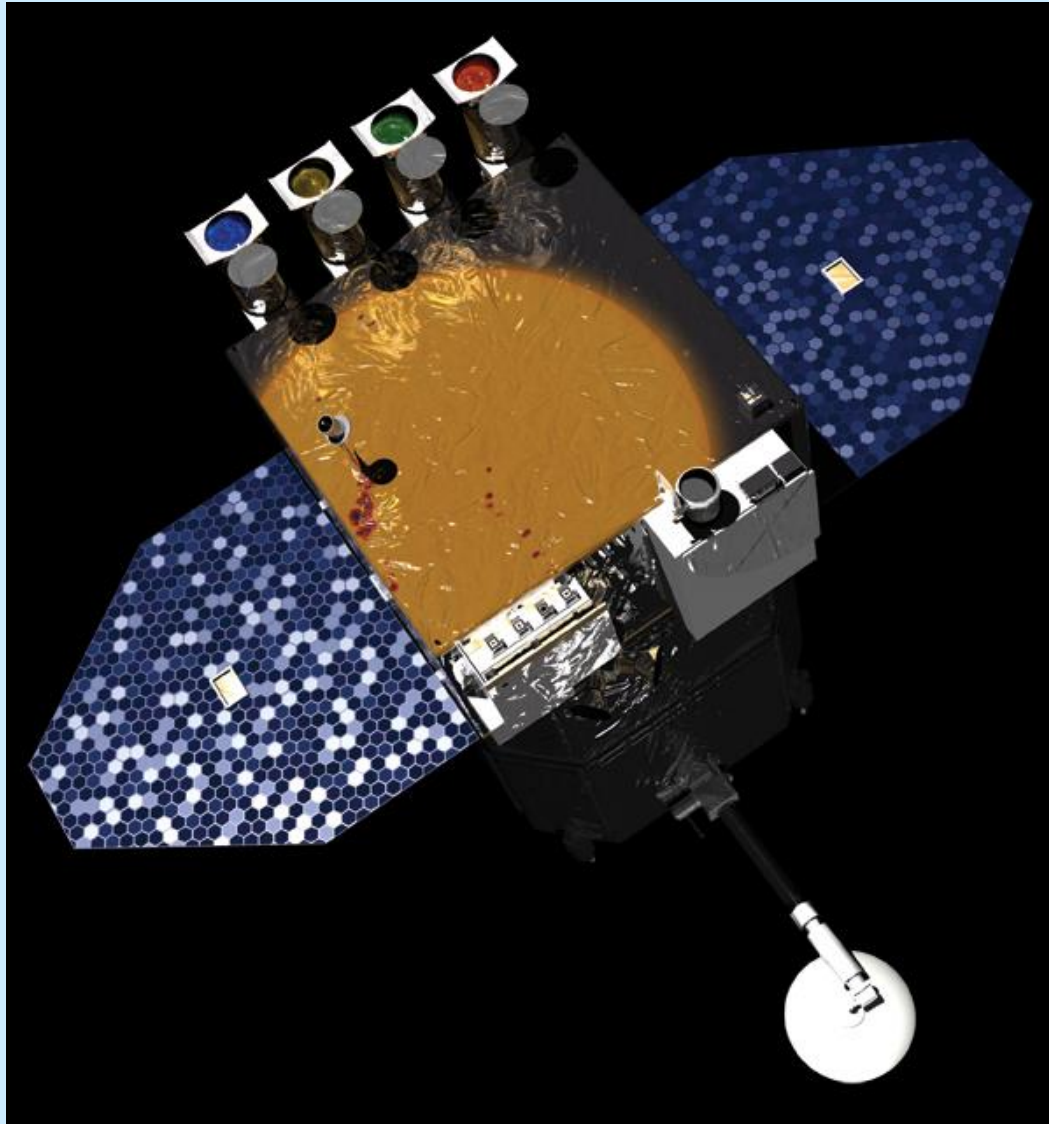


# Hinode/EIS – an active region

## Intensity and flows (Doppler shifts) in Fe XII 2MK



# Atmospheric Imaging Assembly

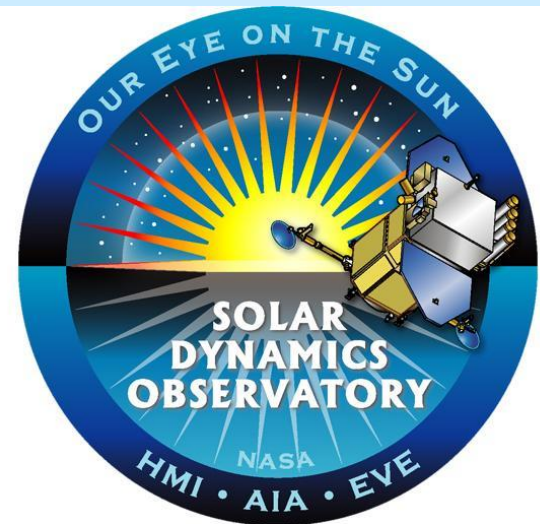
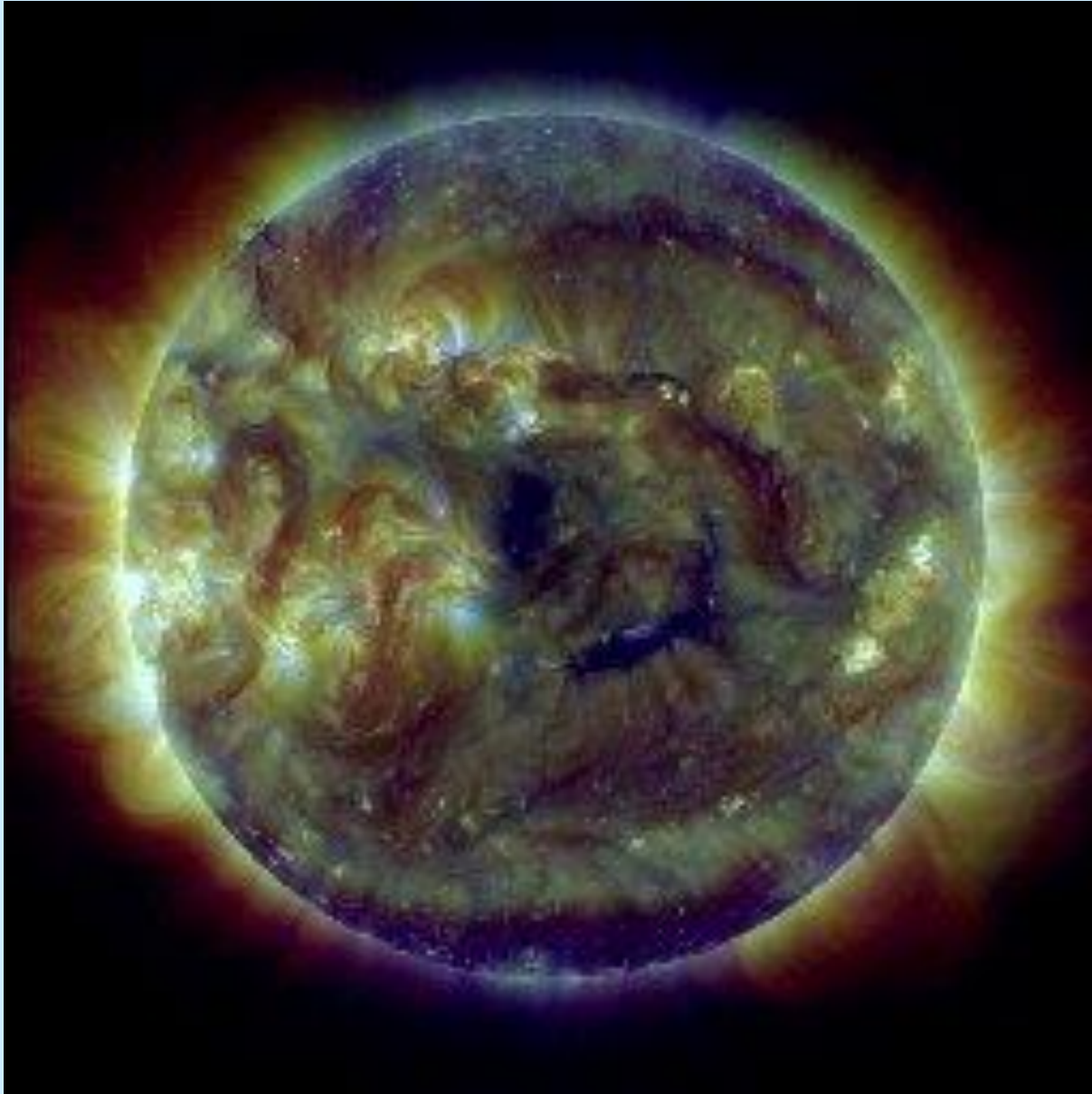


**Solar Dynamics  
Observatory:**  
NASA, launched 2010

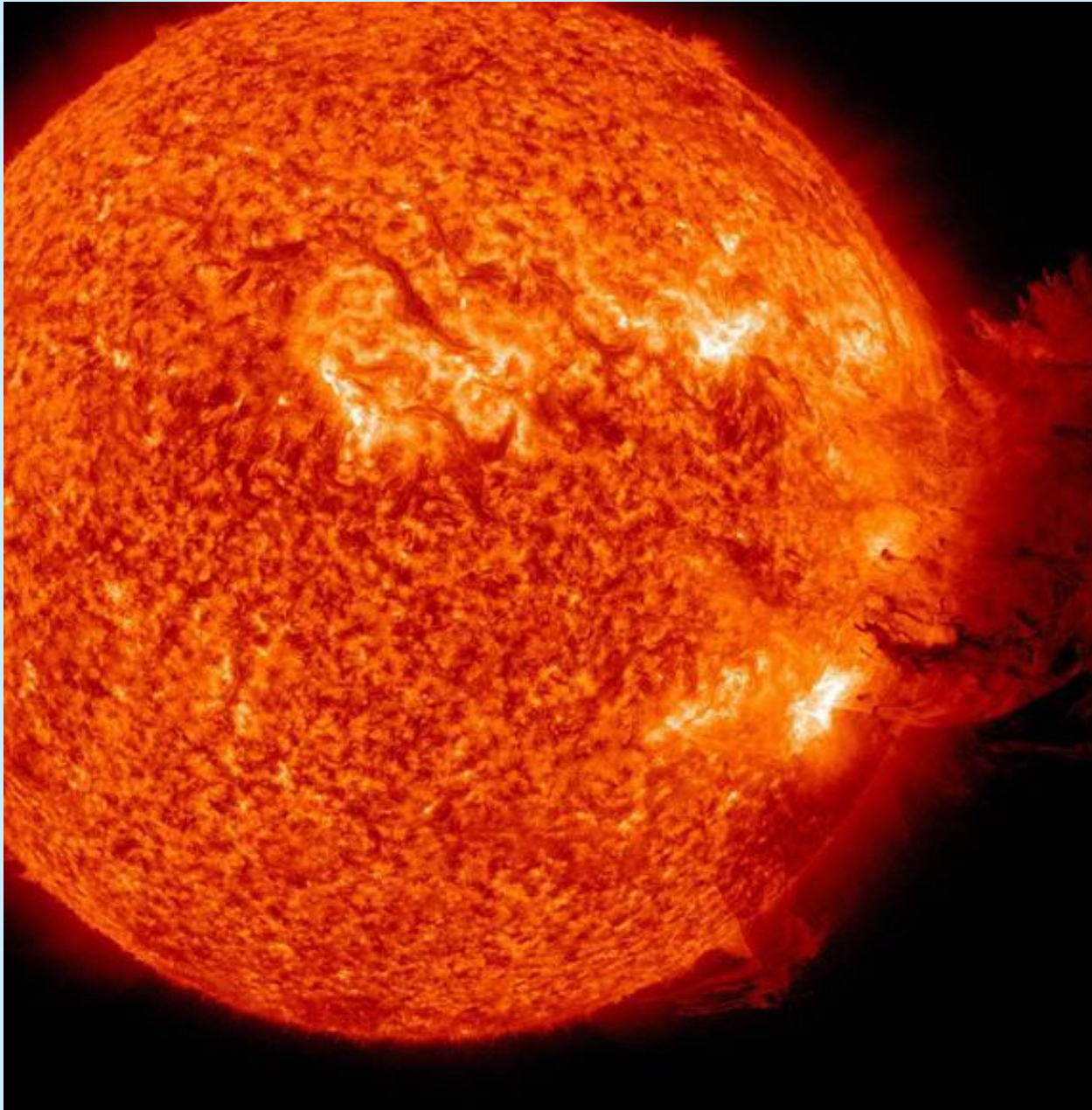
**Atmospheric Imaging  
Assembly (AIA):**

- successor to SoHO/EIT and TRACE
- four identical EUV full-disc telescopes, state-of-the-art
- cadence of **12 seconds**
- **0.6" px size, 1.5" resolution**
- broad temperature coverage to study coronal and flare physics

# The Sun – 21<sup>st</sup> March 2015



# Solar Dynamics Observatory



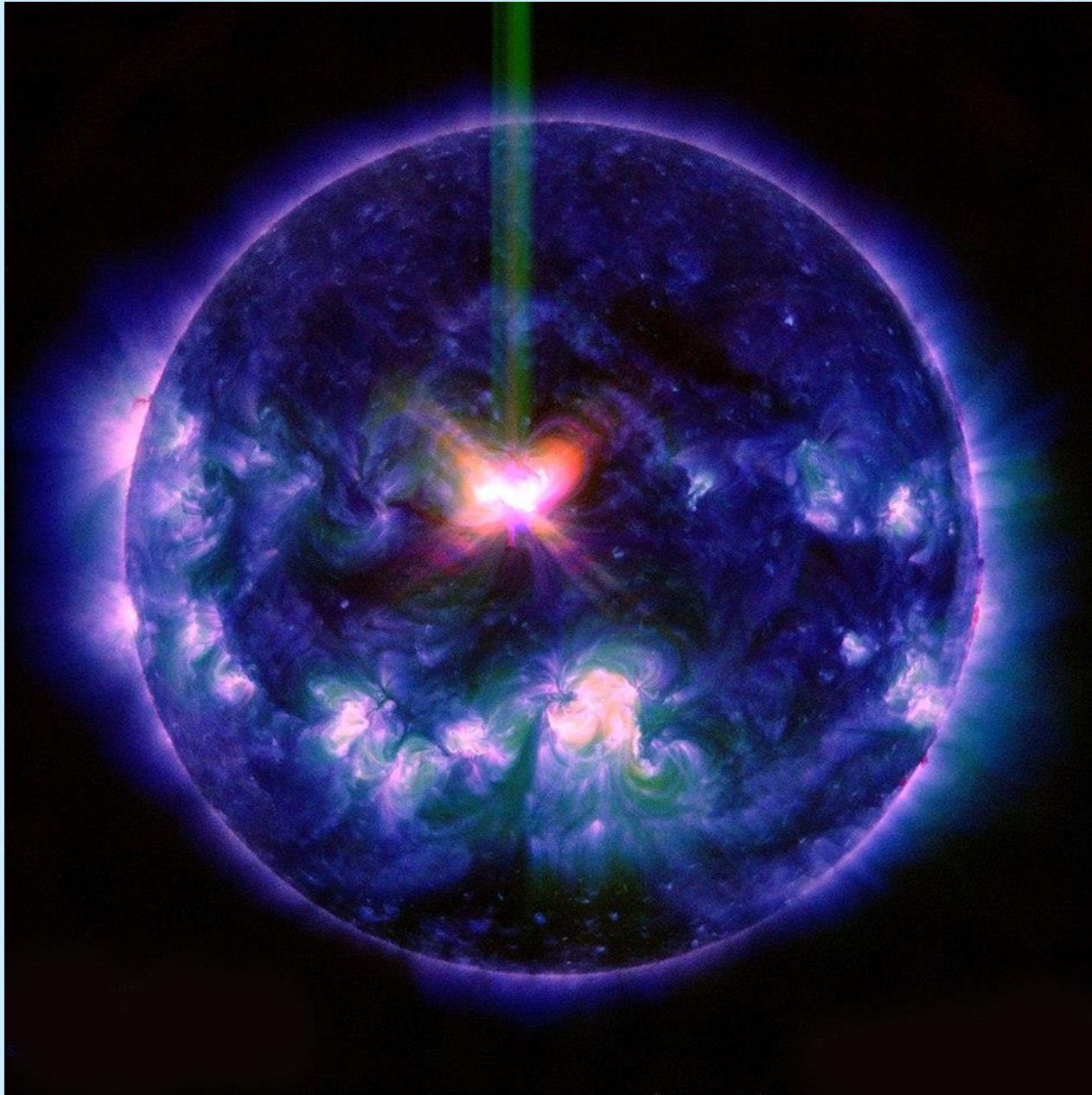
**June 7 2011**

**Spectacular  
solar eruption!**

**Emission from  
He II 30.4 nm**

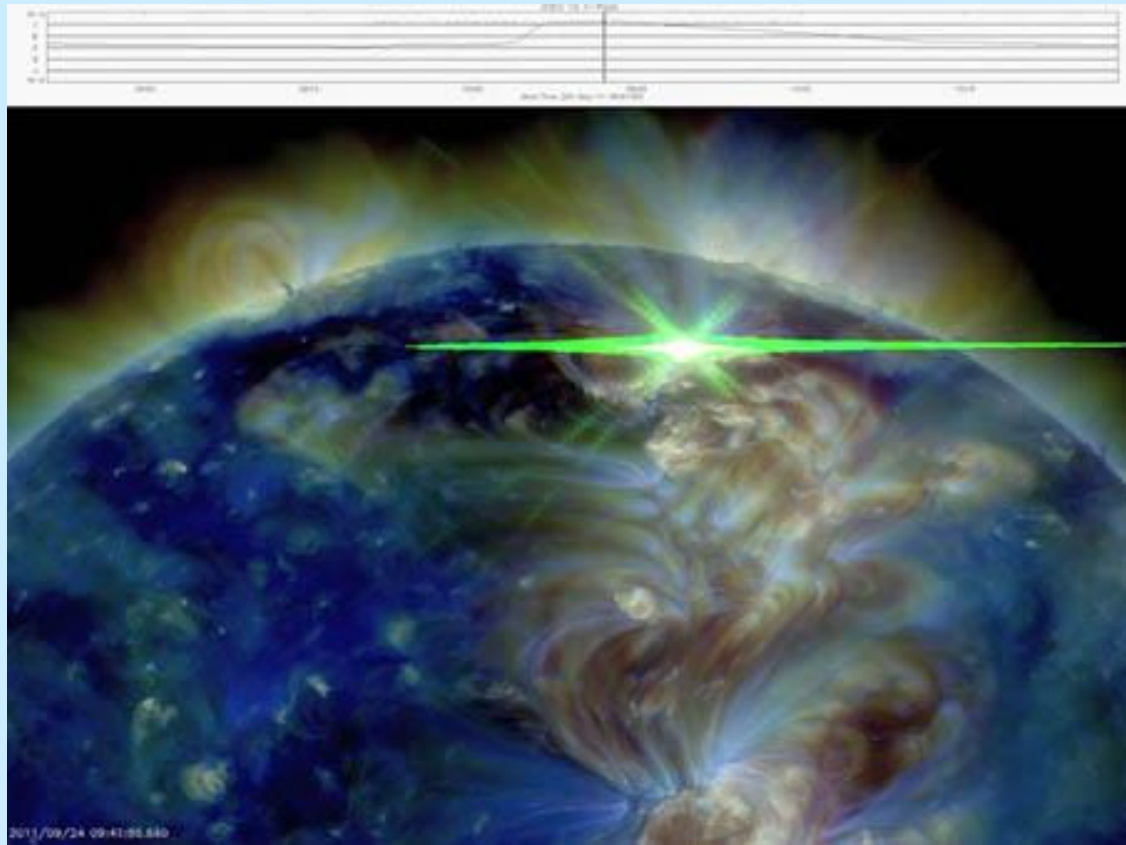
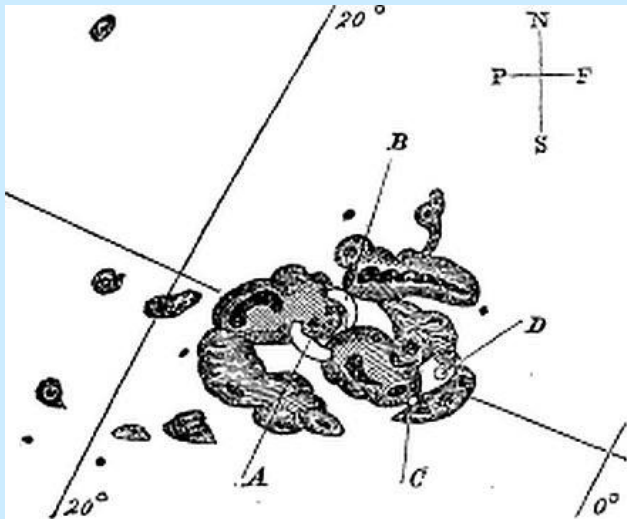


# X class flare – 10<sup>th</sup> Sept.2014

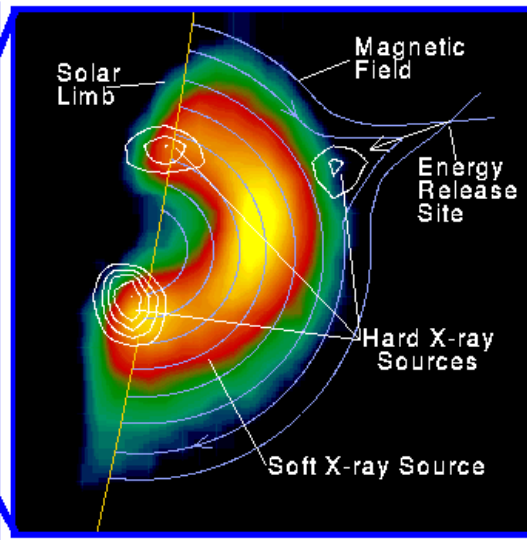
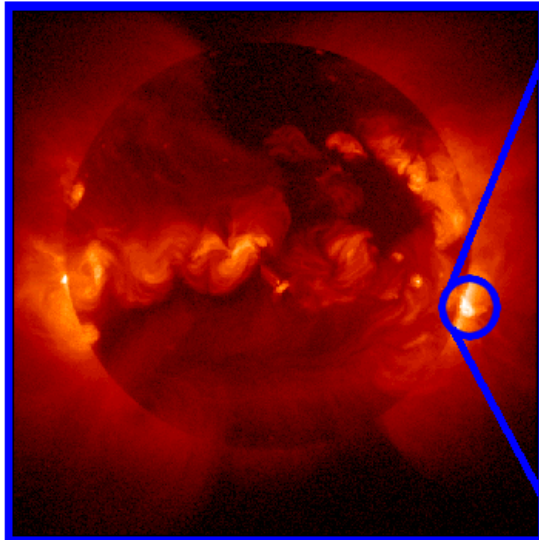
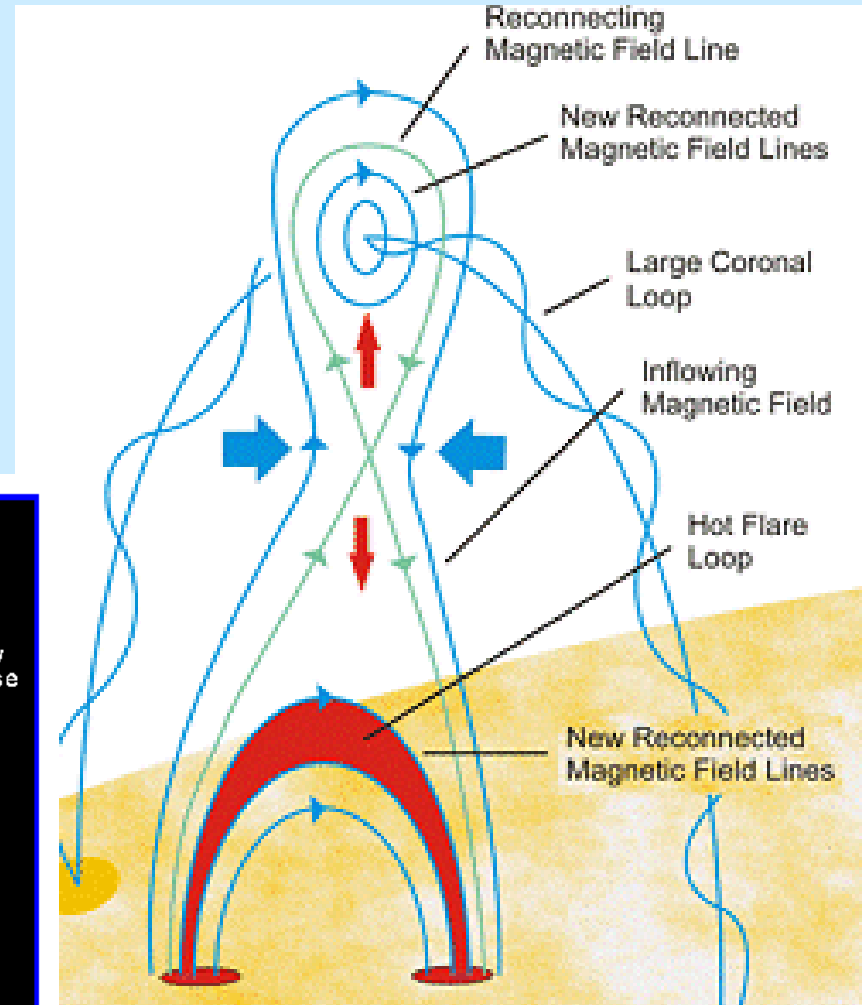
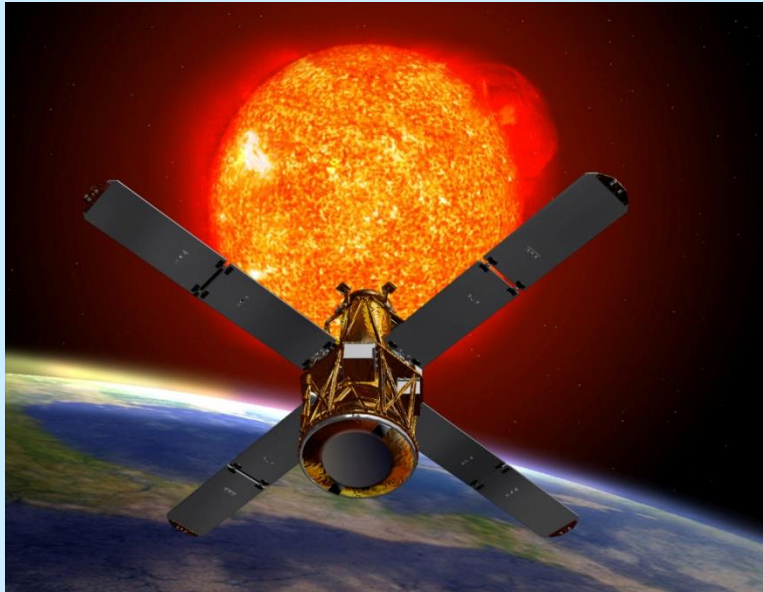


# X-class flares

Carrington and Hodgson are credited with seeing the first solar flare on September 1<sup>st</sup> 1859. It was very bright in visible light, and must have been an X-class flare, resulting in an aurora.

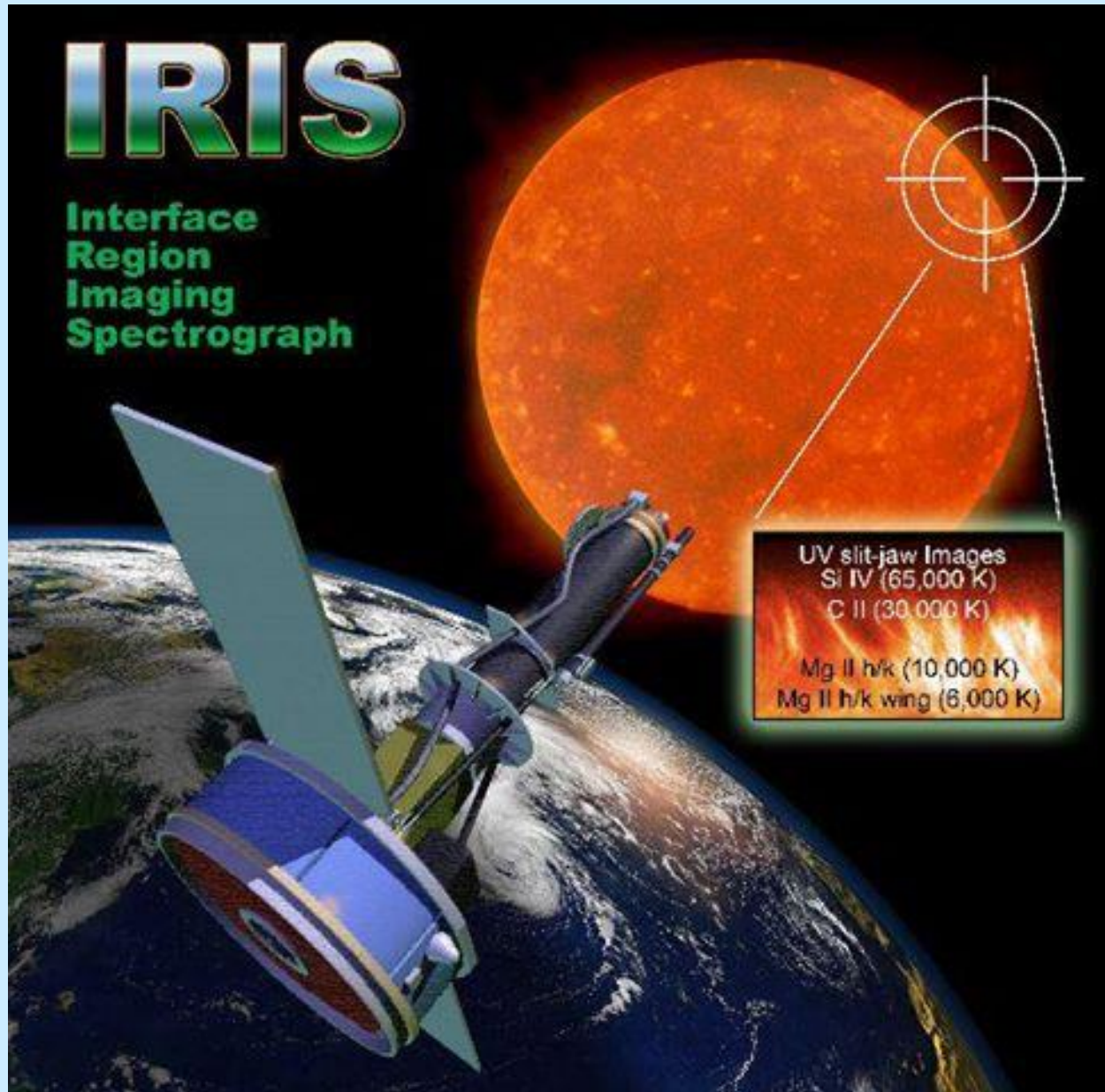


# RHESSI - solar flares

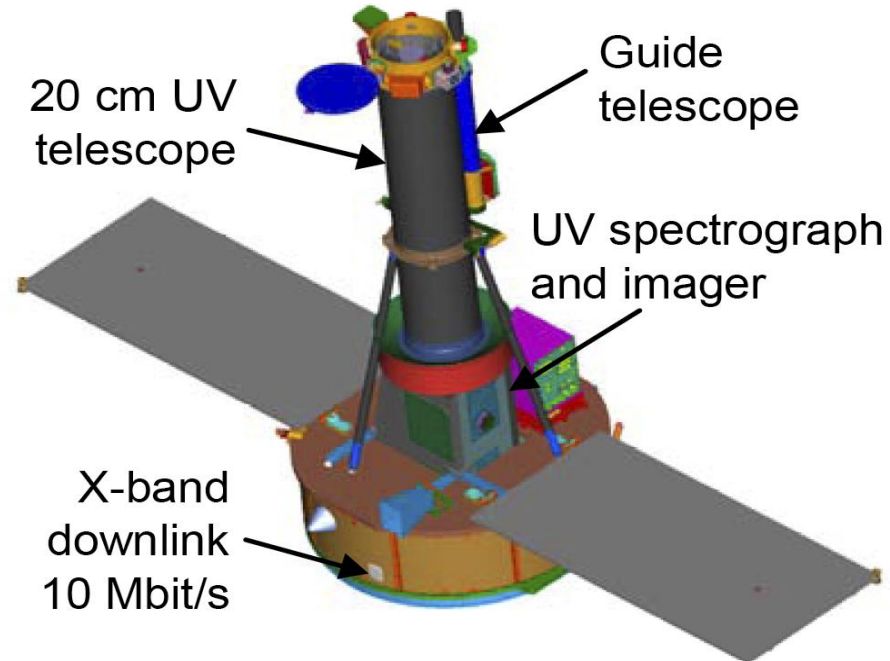
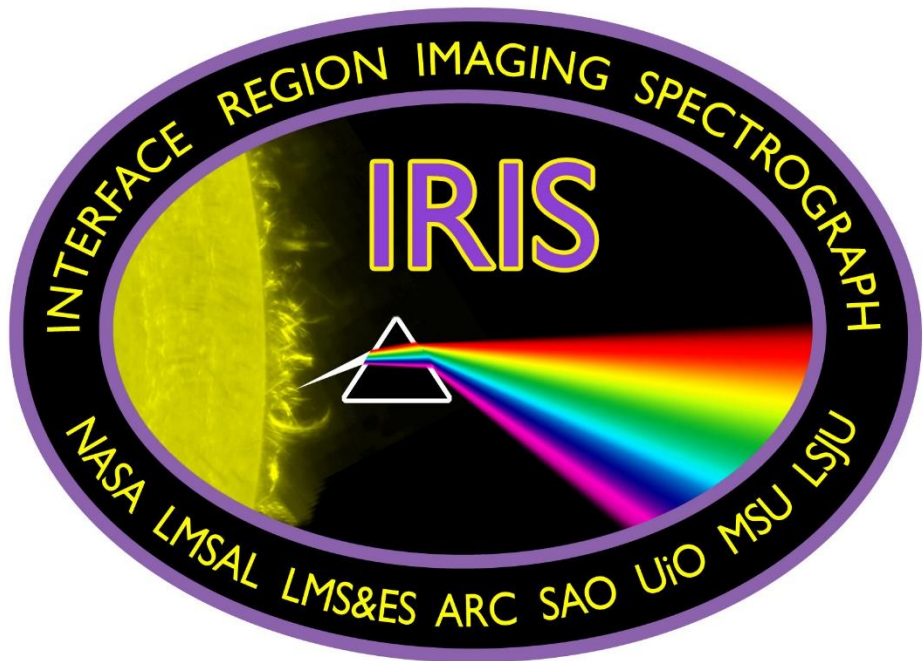


Yohkoh X-ray Image of a Solar Flare, Combined Image in Soft X-rays (left) and Soft X-rays with Hard X-ray Contours (right). Jan 13, 1992.

# IRIS launched in 2013



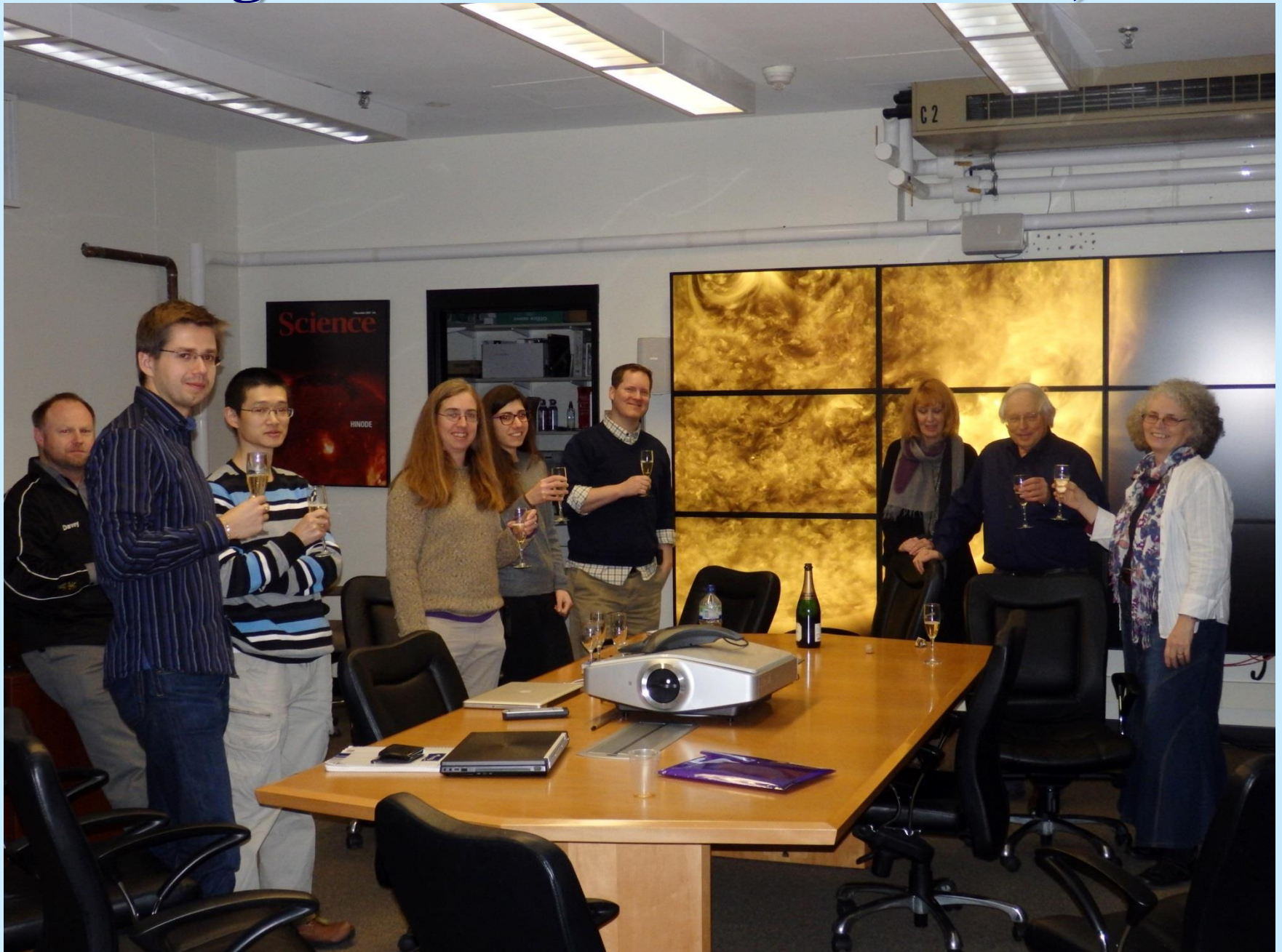
# The IRIS Instrument



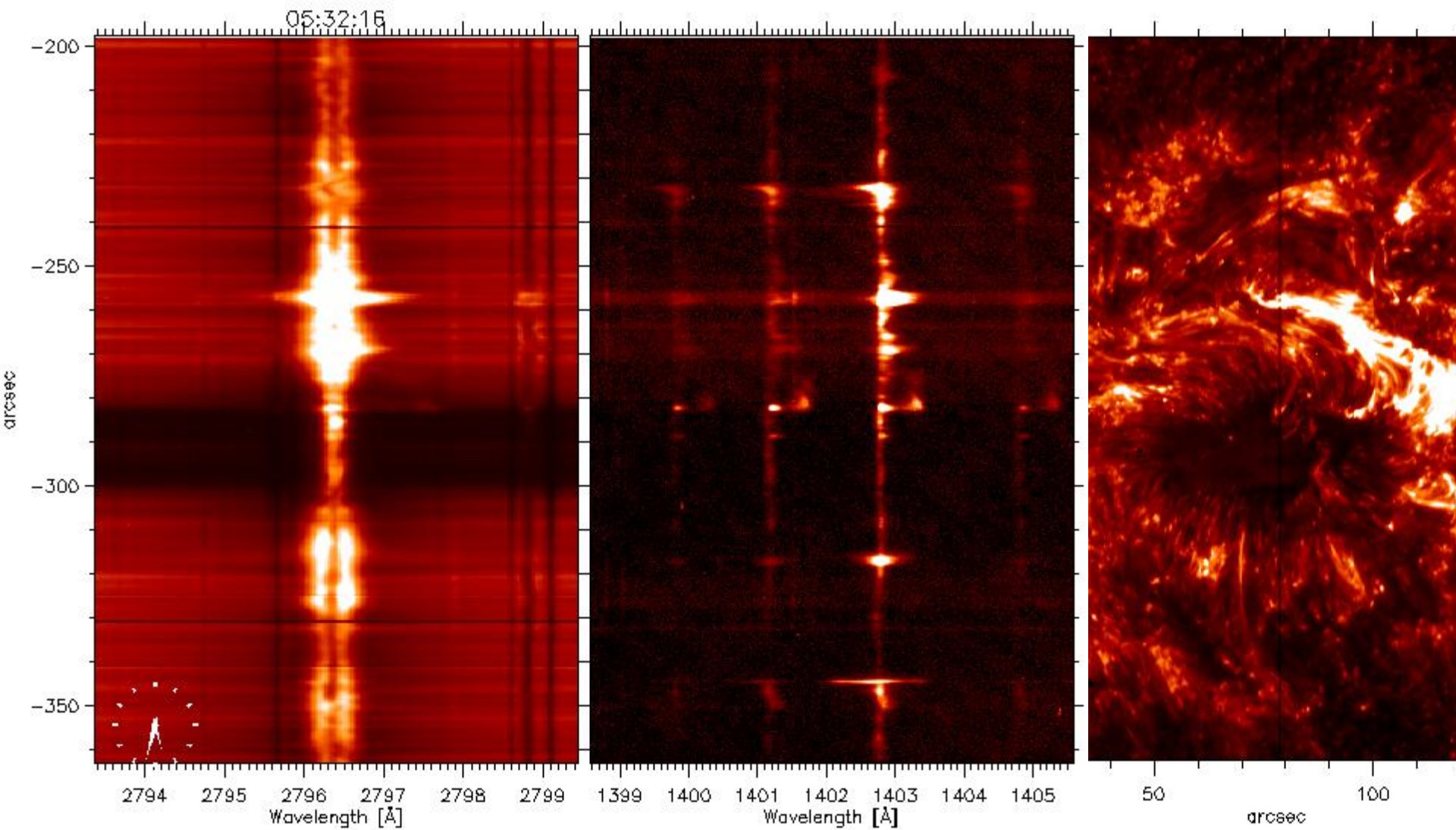
## NUV and FUV Spectra Characteristics

SG Passband	Wavelength range (Å)	Spectral Dispersion (mÅ)	Spatial range (arcsec)	Spatial pixel size (arcsec)	CCD/ Camera	Shutter	Effective Area (cm <sup>2</sup> )
FUV 1	1331.6-1358.4	12.98	175	0.166	1, CEB1	FUV SG	1.3
FUV 2	1380.6-1406.8	12.72	175	0.166	2, CEB1	FUV SG	1.3
NUV	2782.6-2833.9	25.46	175	0.166	3, CEB2	NUV SG	0.18

# Visiting the IRIS Team at Harvard, USA

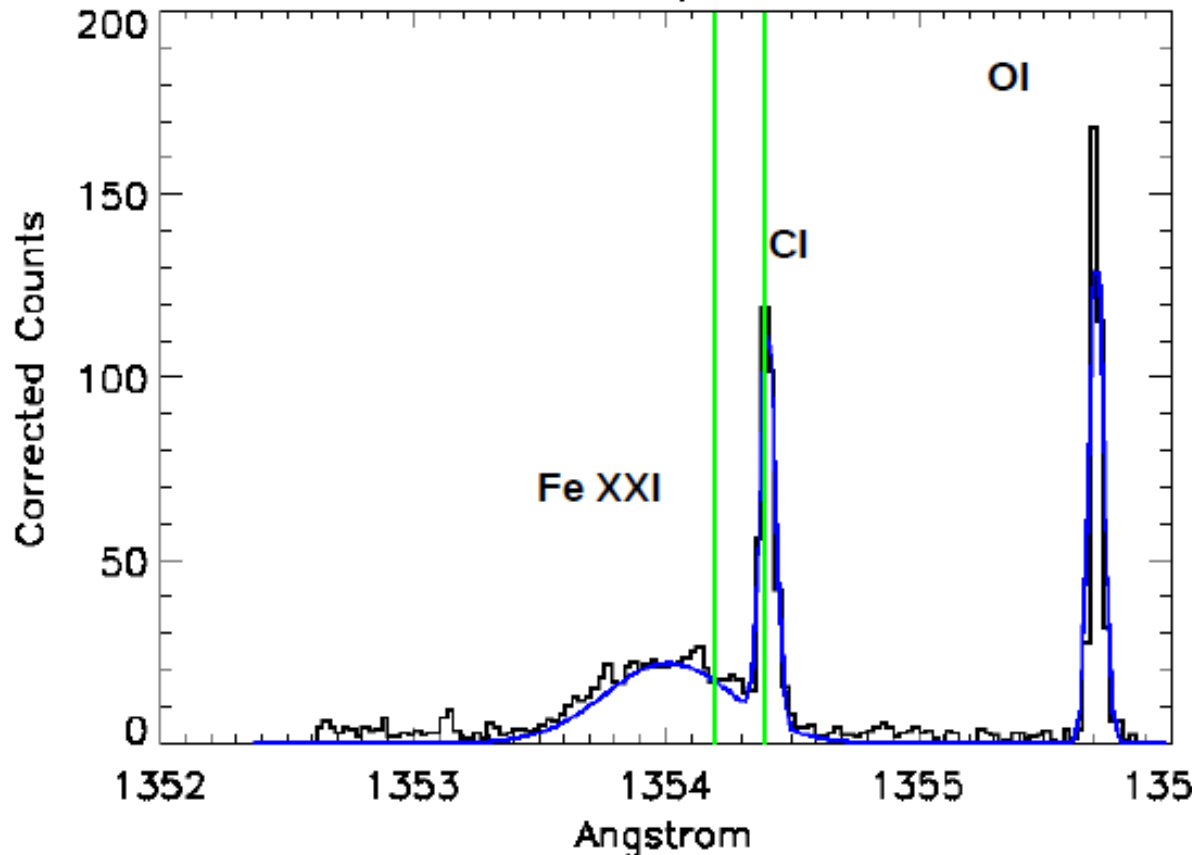


# IRIS Observations



# IRIS Fe XXI spectrum, pos 1

IRIS roster 24, exp 0 13:36:38 UT

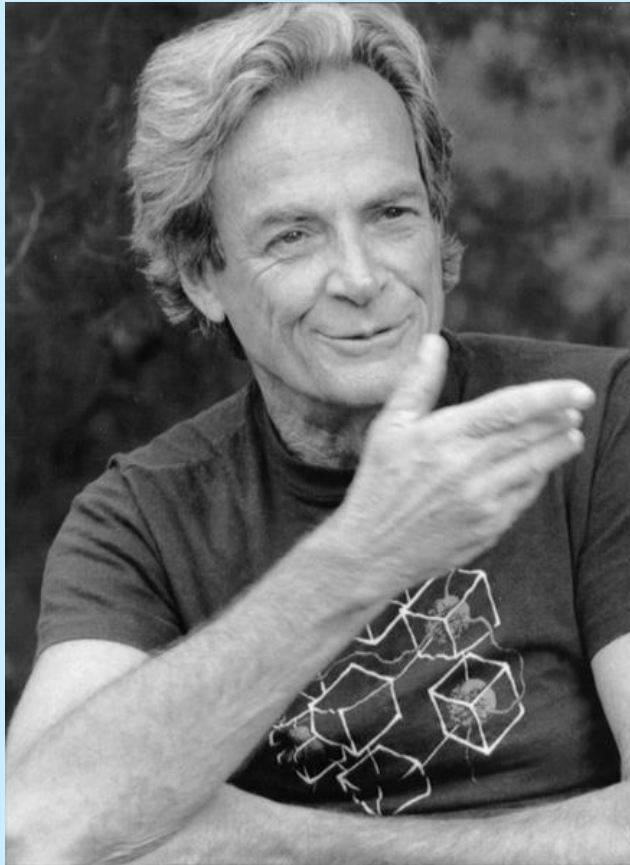


Reference wavelengths (green) for Fe XXI and Cl determined from OI, taking the observed wavelengths from literature (High resolution solar spectrum, Skylab 1986)





# Richard Feynman

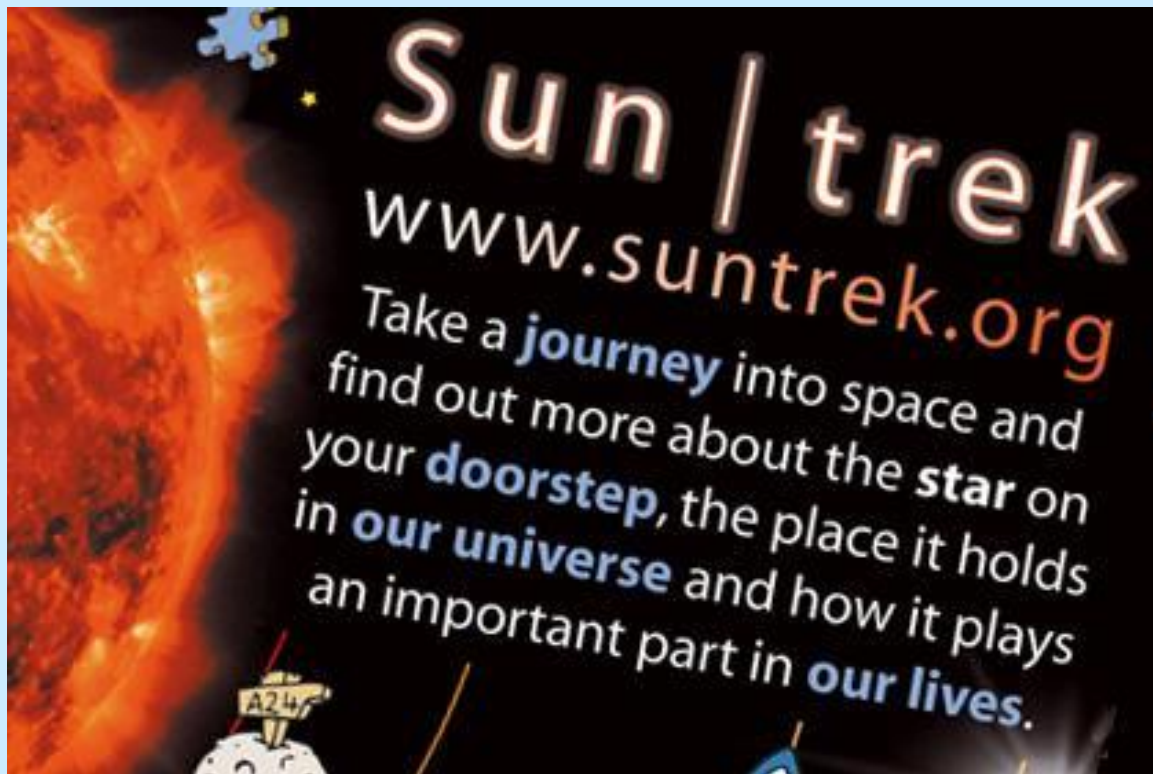


**“You can know the name of a bird in all the languages of the world, but when you're finished, you'll know absolutely nothing whatever about the bird... So let's look at the bird and see what it's doing -- that's what counts.”**

sun | trek

**Sun | trek** is an educational website created by UK solar researchers and teachers, led by Helen Mason.

**Sun | trek** is targeted at students aged 11-15 years old.

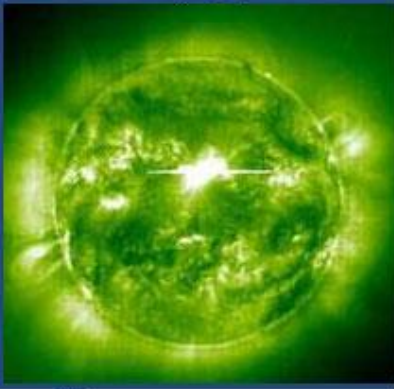




Sun|trek adventures

Sun|trek homepage

Sun|trek homepage



- Homepage
- A quick tour
- Sun|trek adventures
- Solar guides
- Factory
- Gallery
- School Projects
- Classroom Resources
- Hot news
- Contact us
- The Sun|trek Team
- Useful links & resources


Welcome to Sun|trek. Take a journey into space and find out more about the Sun and its effect on the Earth..

### Hinode

Using Hinode, we hope to better understand the connection between the Sun's magnetic field and its corona.

Some of the most startling movies and amazing results are being obtained.



What's New	What's Hot	School Stuff
<p>Check out our latest section on Solar Eclipses</p> 	<p>STEREO HINODE IHY</p> 	<p>Classroom Resources</p> <p>Schools Projects</p> 



There's lots of cool stuff on Sun|trek, dive in and **start exploring here**

We can't do your home work for you, but if you have a question about the Sun you can always **ask the Sun|trek team**



Check us out on



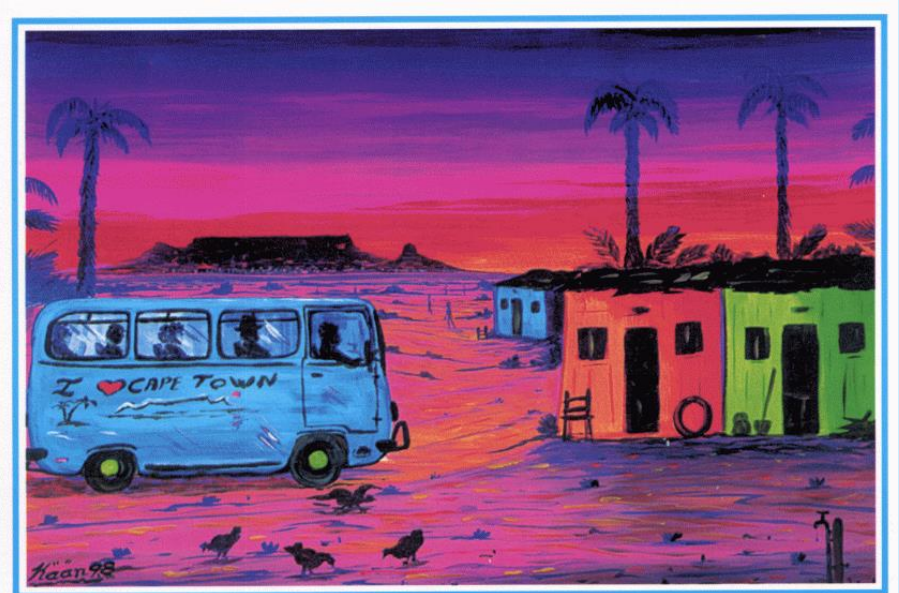
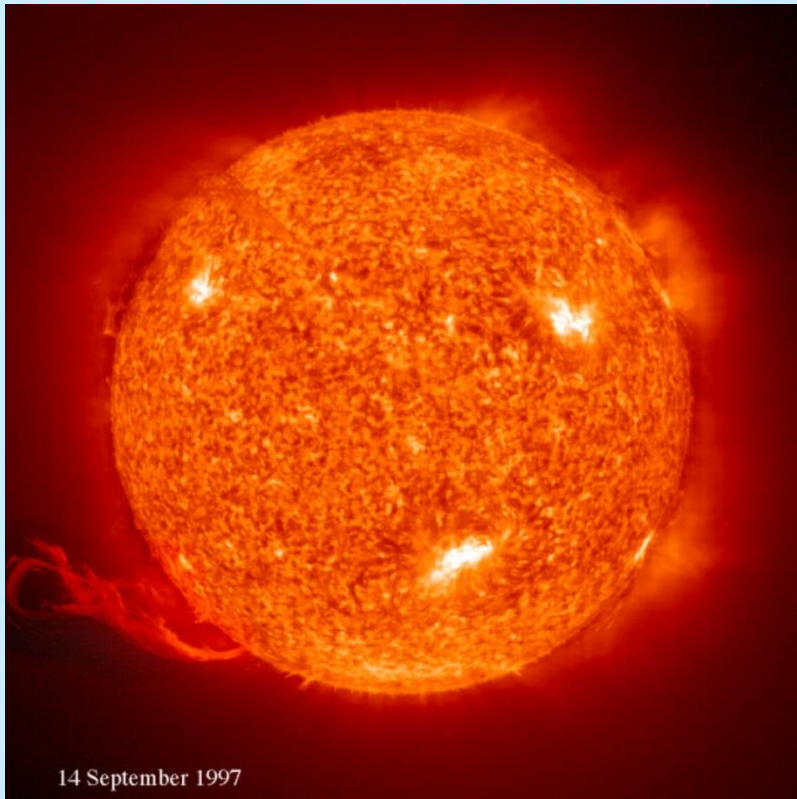
follow us on **twitter**

# Science and Mathematics in Africa



# One of the African learners said:

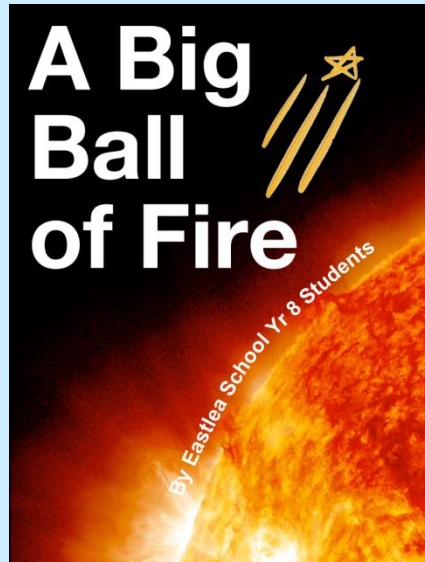
Dr Mason mentioned Galileo, Newton and Einstein are no longer with us, but we the children of the rainbow nation could become the scientists of the future.



# Working in India



# iBook Launch at the Science



# Hot Spot

## Hot Spot



Come to see our sun project, **HOT SPOT!!**

Where we show you our different views on the sun from Solar flares to Sunspots and The Lunar Eclipse to The Solar Eclipse.

You will have lots of fun at the vent while listening to music by some of our talented pupils.

Join us in Artist in Residence Room in the 6th Form

On Wednesday 11th June 3:30-5:30

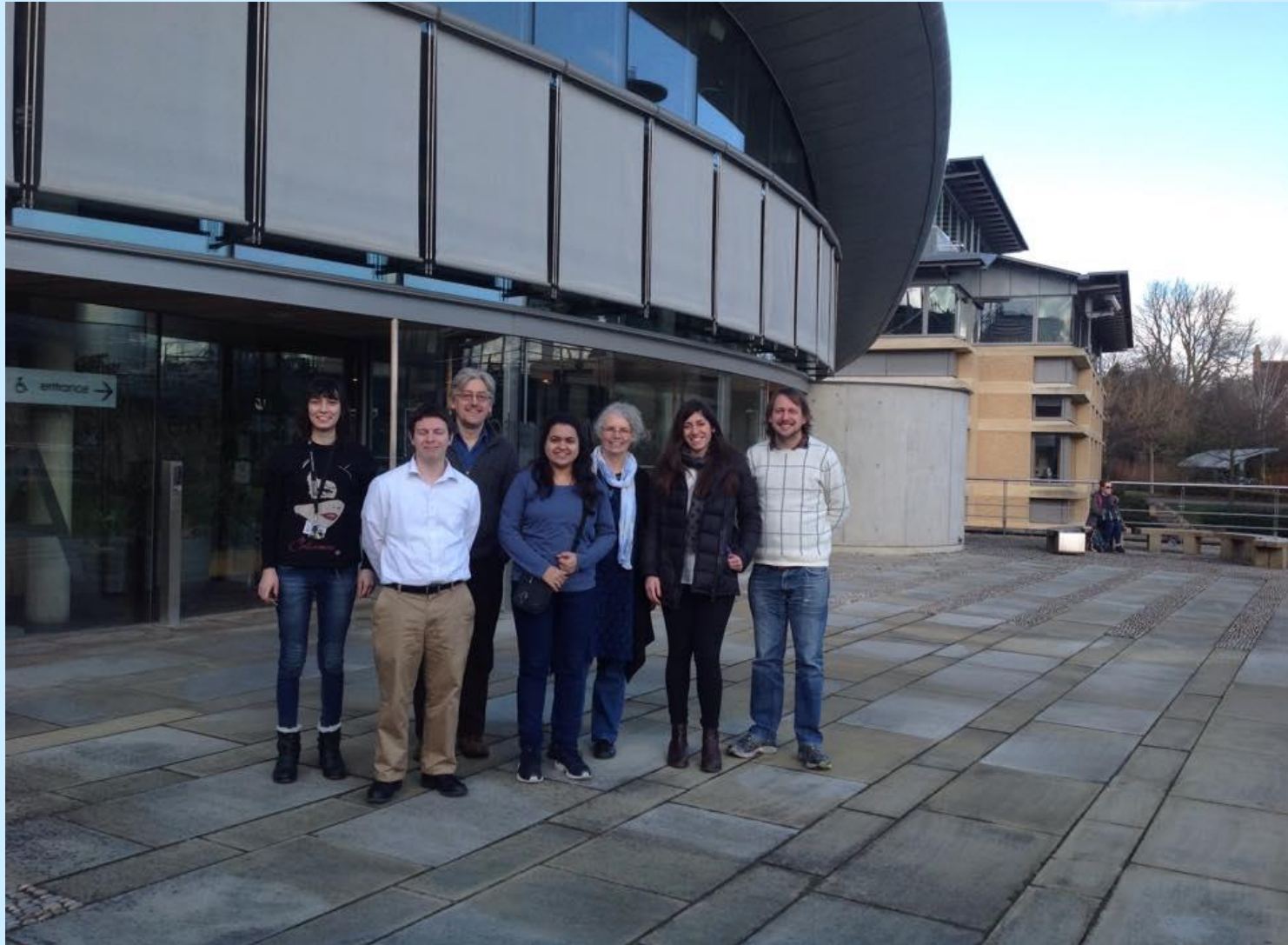
# St Ambrose Barlow High School, Salford May/June 2014





# A Personal Journey

## Atomic Astrophysics Group, DAMTP



# My Family



**Kira,  
our grand-daughter**



# My Advice to you...



- **Be yourself!**
- **Be true to what matters in your life.**
- **In success, remember those who have helped you.**
- **Treat failure as an opportunity to learn and move forward.**
- **Never be afraid of a new challenge.**
- **You are a strong and capable woman.**

# Thank You!

