

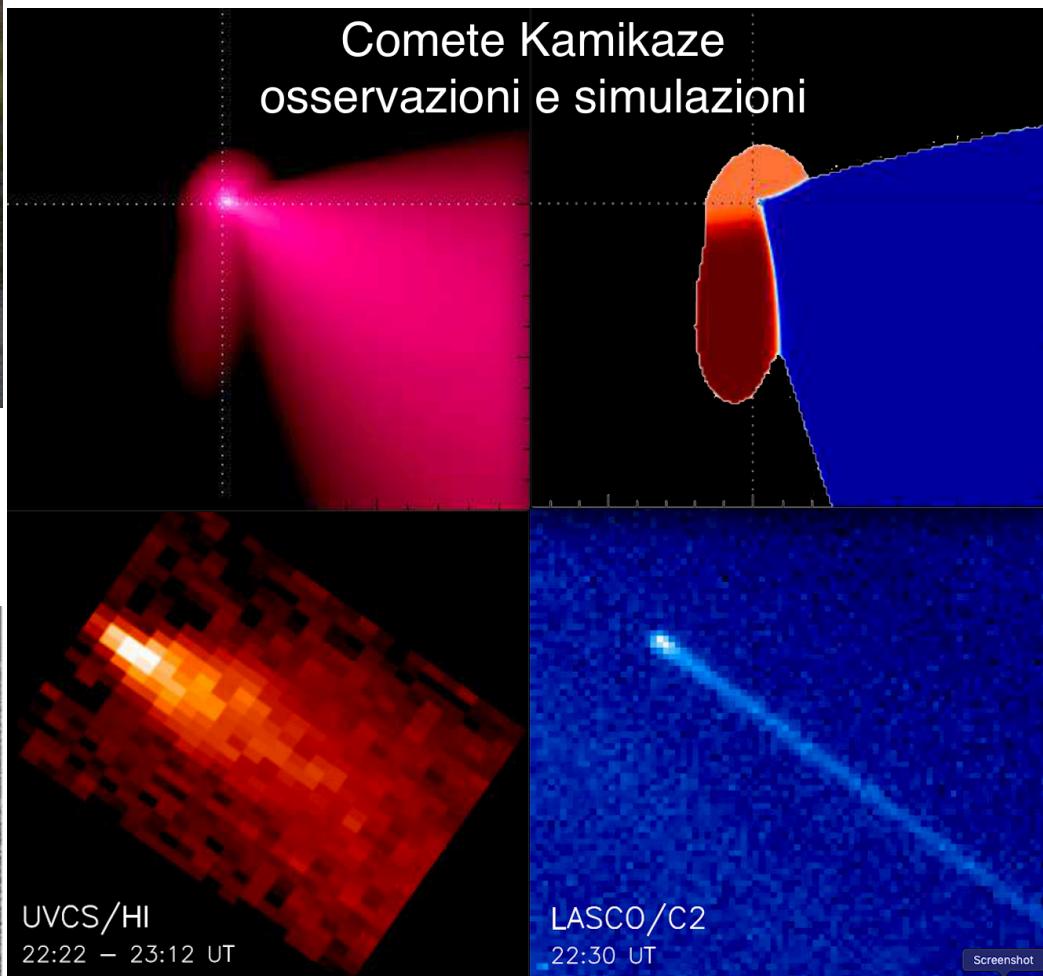


INAF



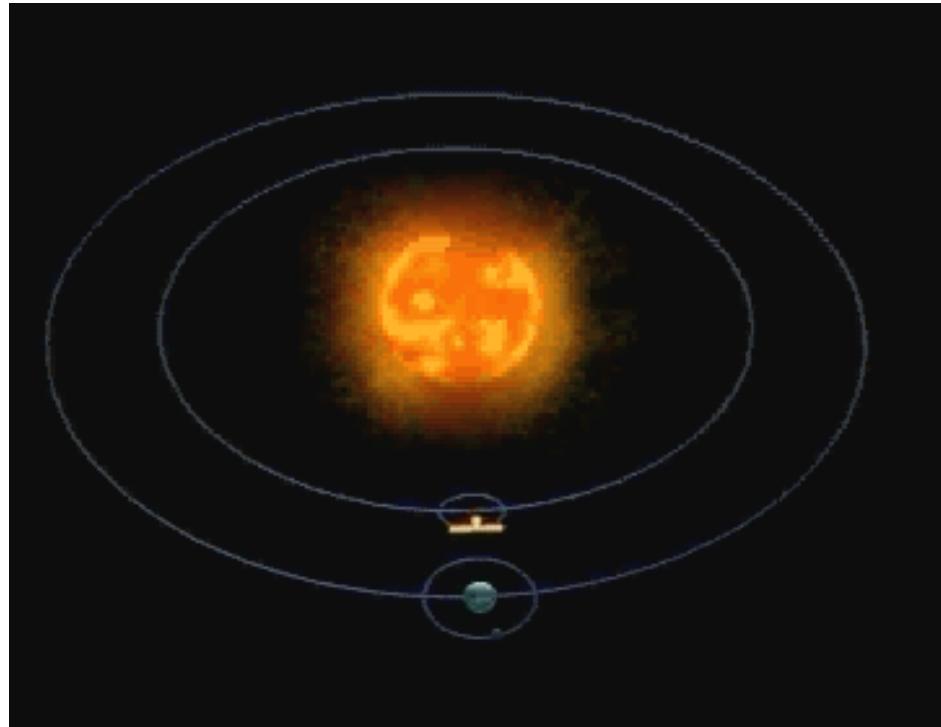
ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

Comete Kamikaze osservazioni e simulazioni



SOHO mission

- Launch: 1995 ... at present still working !!
- Orbit: L1 (Lagrangian Point)
- Mission Goal: continuous observation of Sun, Corona and Heliosphere
- Coronagraphs & Spectrometers
- detect also **Comets**

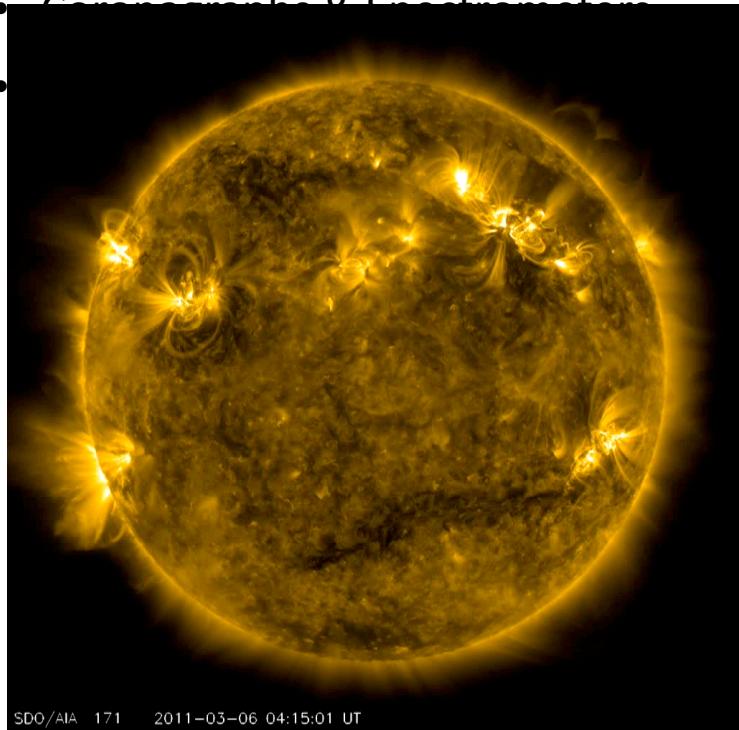


Sungrazing comets

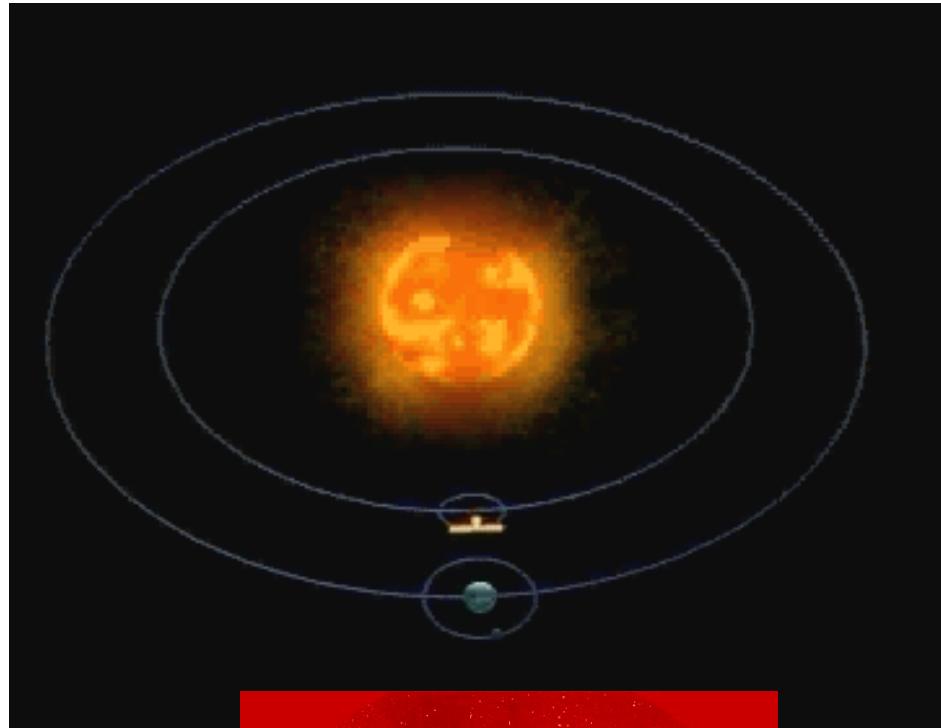
- *study of physical evolution and disintegration of comets*
- *powerful tool to study the coronal parameters (densities, outflow velocity) without any assumption on the line of sight profiles*

SOHO mission

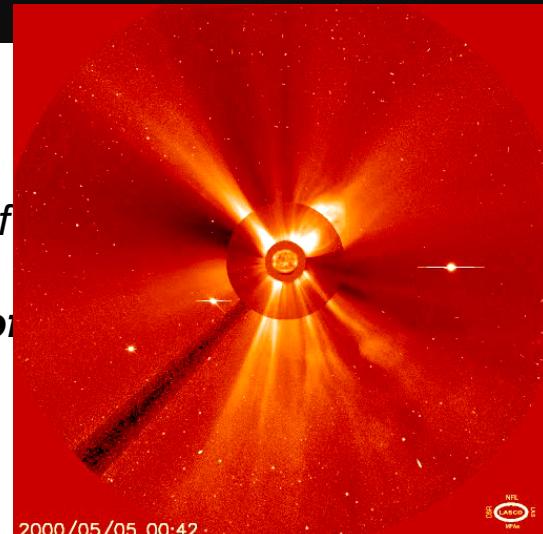
- Launch: 1995 ... at present still working !!
- Orbit: L1 (Lagrangian Point)
- Mission Goal: continuous observation of Sun, Corona and Heliosphere
- Continuous movie: 8 frames every 12 hours
-



SDO/AIA 171 2011-03-06 04:15:01 UT



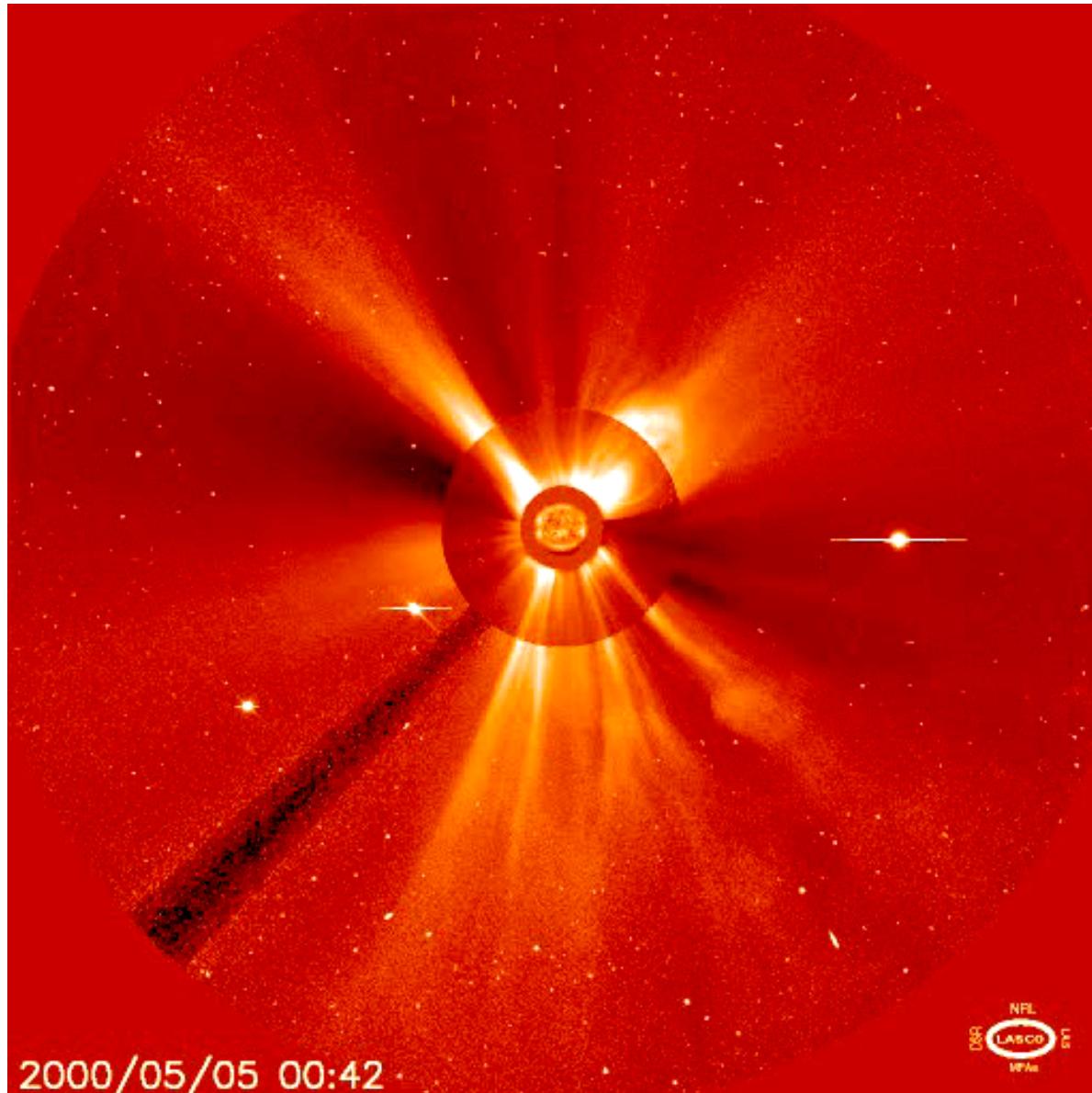
*and disintegration of
planetary parameters
in relation on the line of*



2000/05/05 00:42



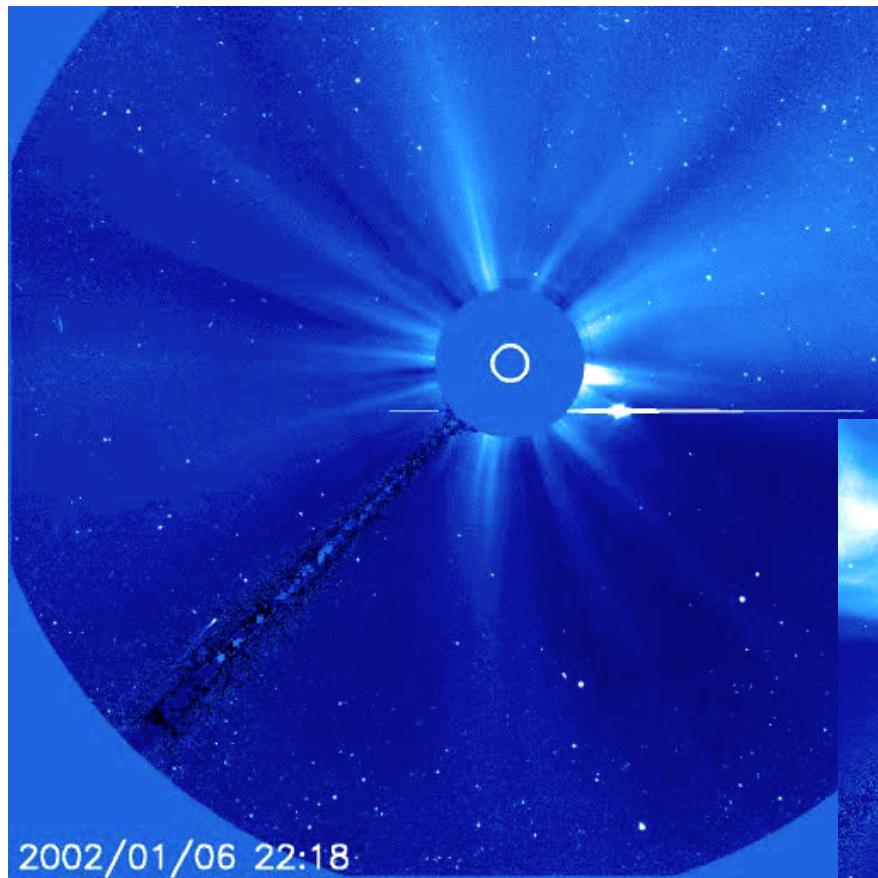
The Sun and Corona as seen from SOHO



Sole
Corona solare
Tempeste Solari
Stelle
Pianeti
Raggi Cosmici
Comete

2000/05/05 00:42

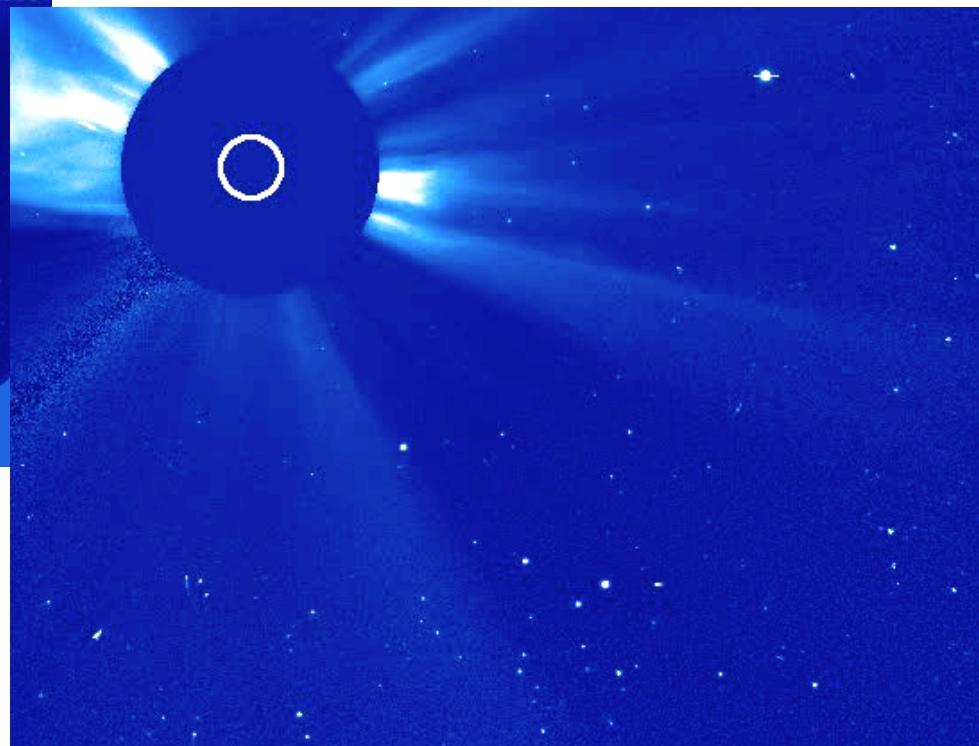
Sungrazing Comets SOHO/LASCO C3



LASCO C3

White light coronagraph

FOV 4.0 – 32 R_☉



Sungrazing Comets SOHO/LASCO C2



LASCO C2

White light coronagraph

FOV 2.4 – 6.0 R_☉

Quante comete sono state scoperte ?

- **da Terra** quasi 1000
 - Di cui 10-15 sungrazers
- **dallo Spazio**
 - Solwind (1979-1985): 6
 - Solar Maximum Mission (1980-1989): 10
 - SOHO (1996-2018): 3800 circa
 - oltre il 95% sono sungrazers
 - circa l'86% appartengono alla **famiglia di Kreutz**

Great Comet of 1680

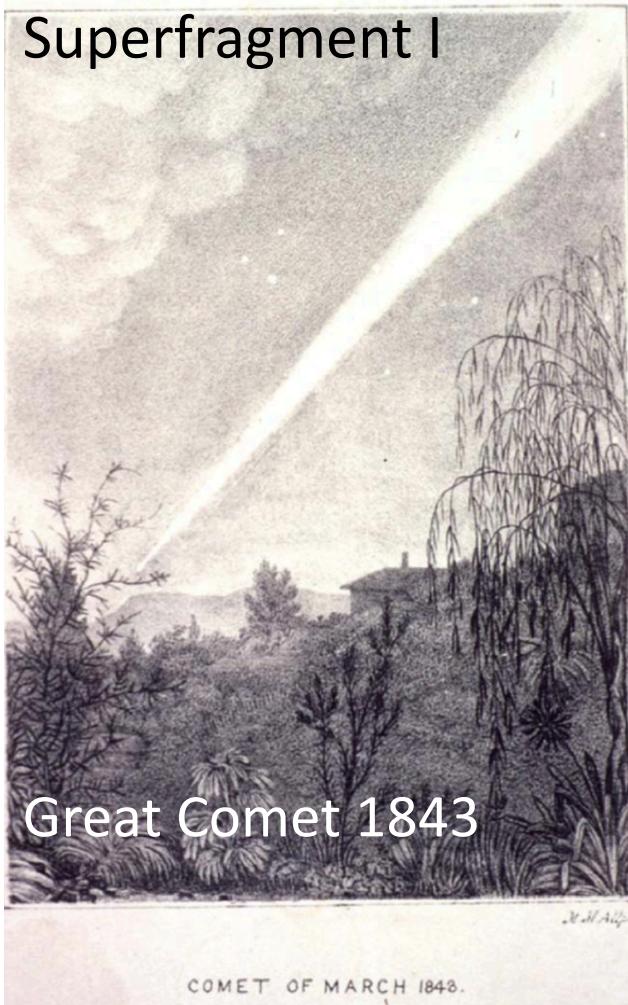
- First observed Sungrazer
- Kepler's Laws
verified
by Newton
- Non-Kreutz



Kreutz Family

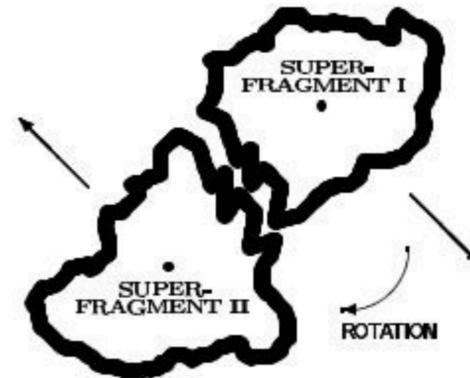
- Progenitor Comet
- 120 km diameter
- Fractured into two ~56 AD

Superfragment I

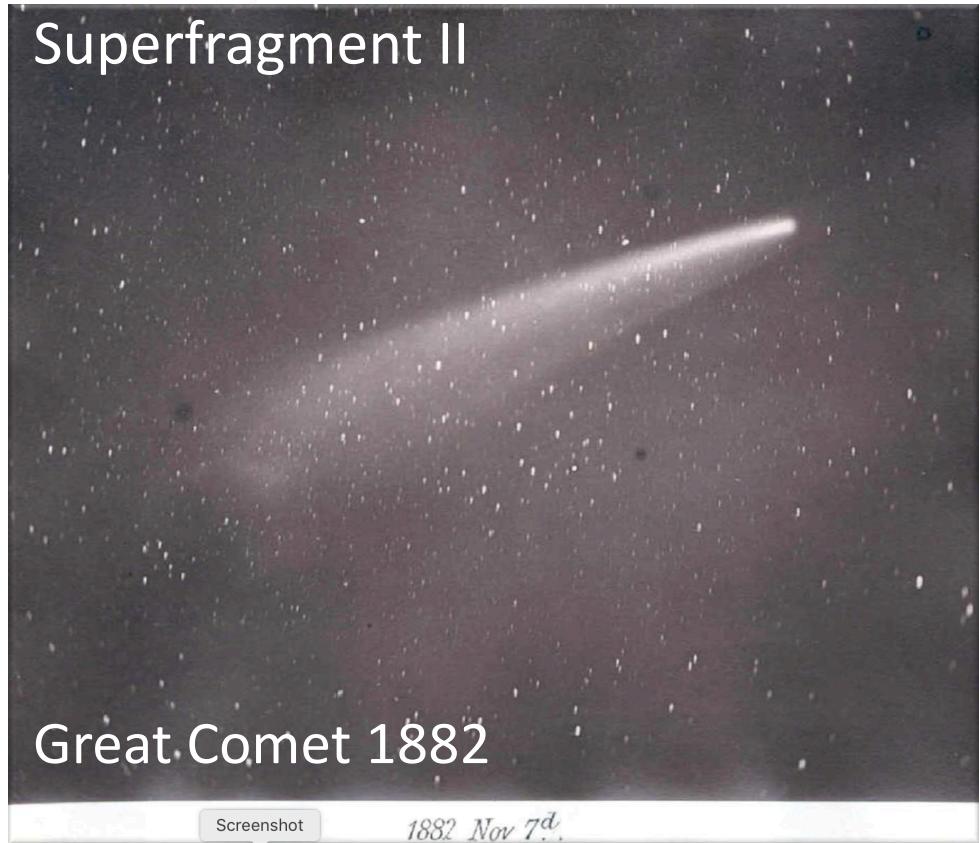


Great Comet 1843

FRAGMENTATION OF PROGENITOR
GIVING BIRTH TO SUBGROUPS
(SCHEMATICALLY)



Superfragment II



Great Comet 1882

Screenshot

1882 Nov 7^d.

Kreutz Family

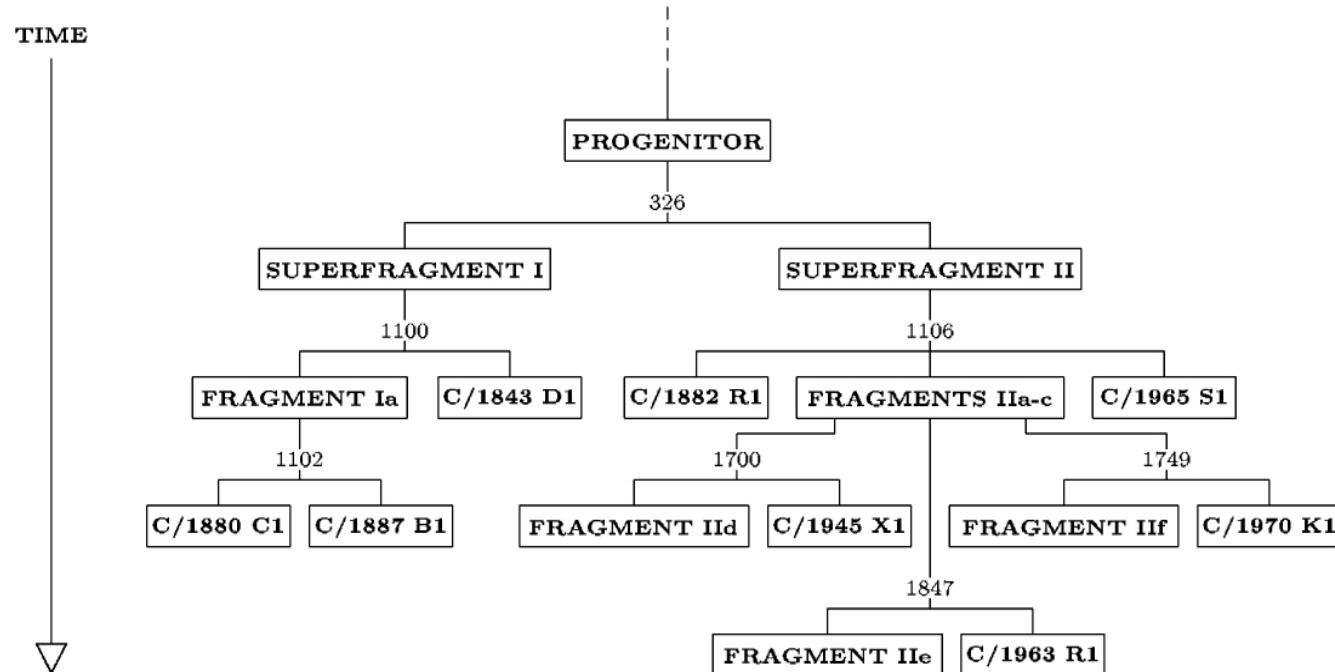
- Progenitor Comet
- 120 km diameter
- Fractured into two ~56 AD

FRAGMENTATION OF PROGENITOR
GIVING BIRTH TO SUBGROUPS
(SCHEMATICALLY)



Super

FRAGMENTATION HIERARCHY OF MAJOR SUNGRAZERS (TWO-SUPERFRAGMENT MODEL)



Great Comet 1882

COMET OF MARCH 1848.

Screenshot

1882 Nov 7^d

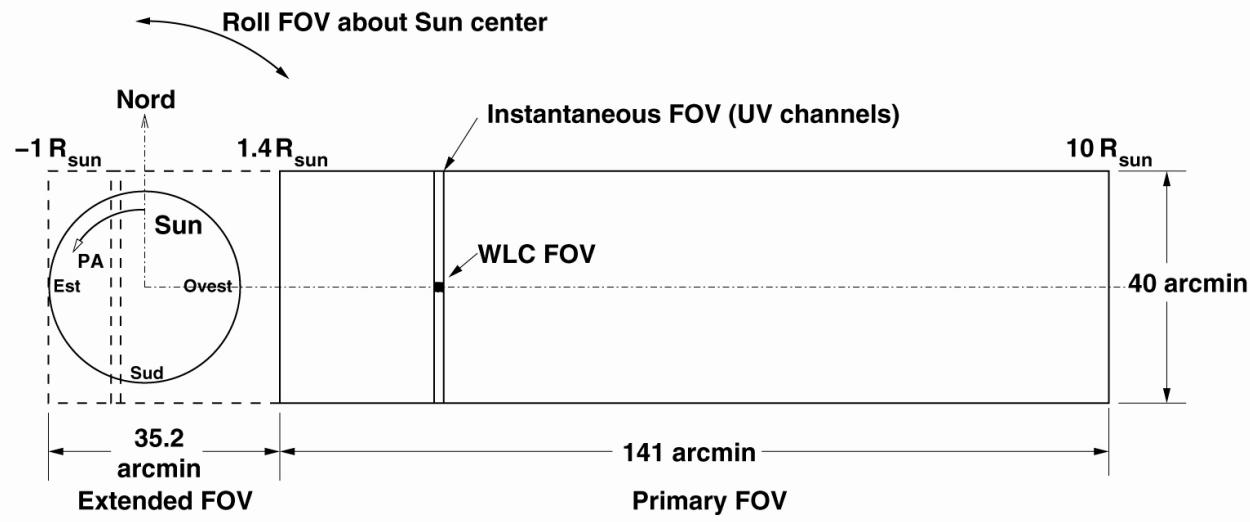
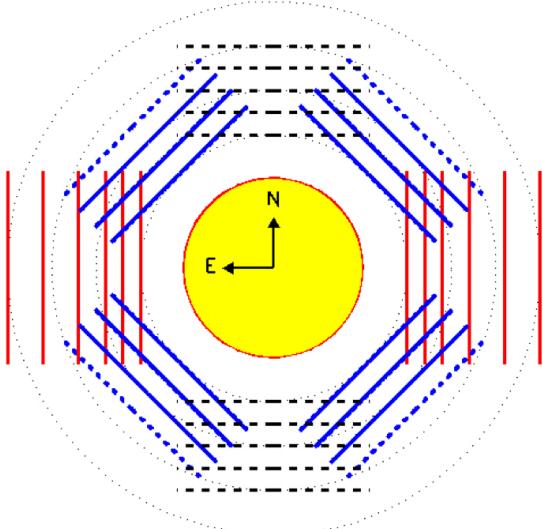
UVCS on SOHO

UltraViolet Coronagraph Spectrometer

Internally and externally occulted coronagraph

Main Scientific Goals: Solar Wind Acceleration
Coronal heating
Coronal composition
Coronal Mass Ejections

Detector: 1024x360
Pixel size: 7" spatial
0.1 Å spectral



FOV: from 1.4 to $10 R_{\odot}$

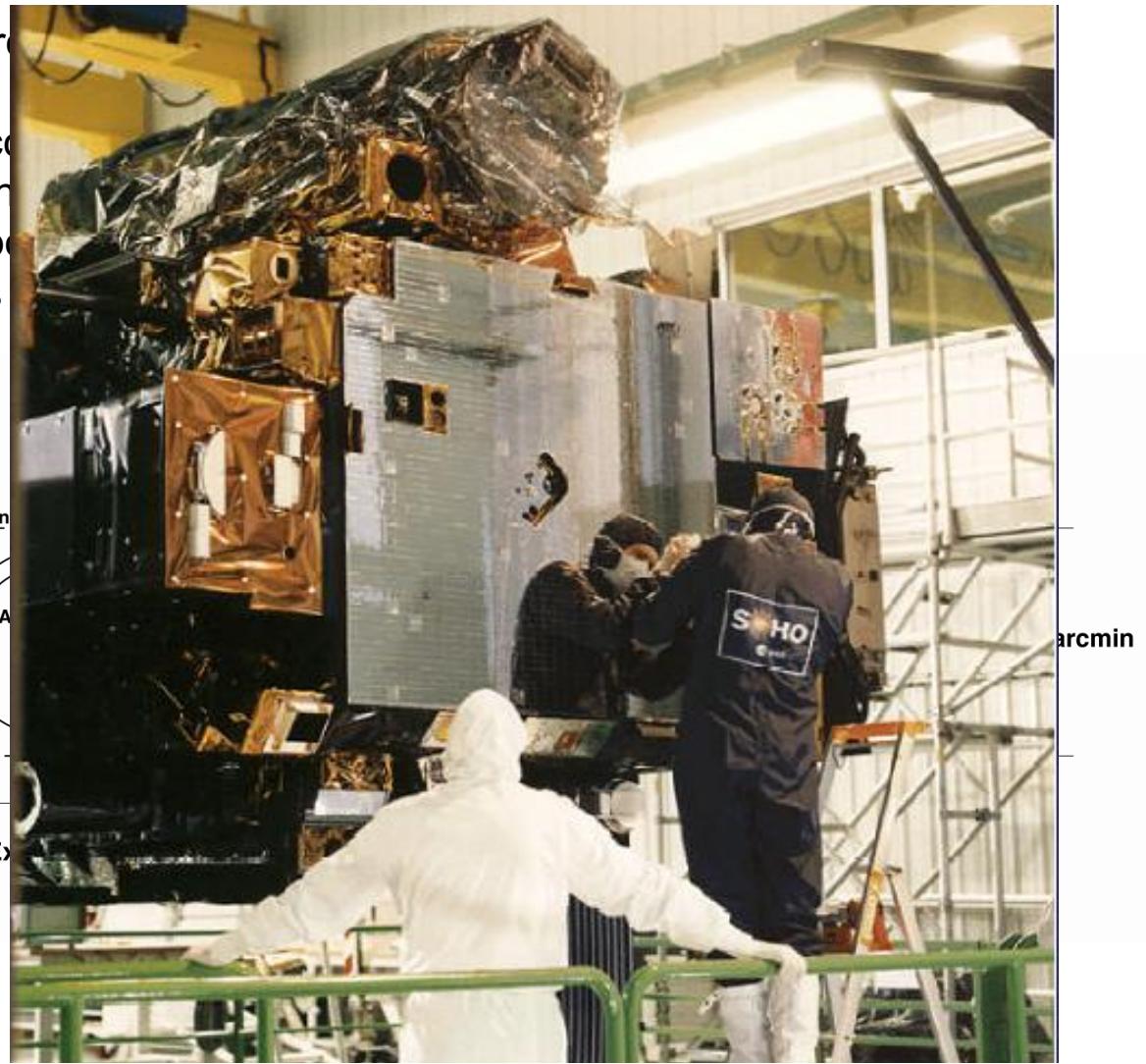
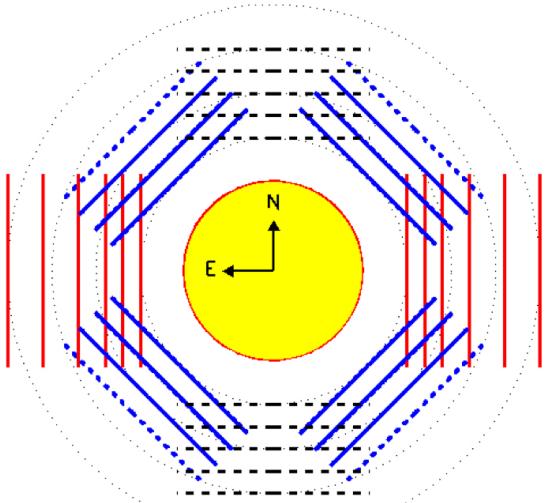
UVCS on SOHO

UltraViolet Coronagraph Spectrometer

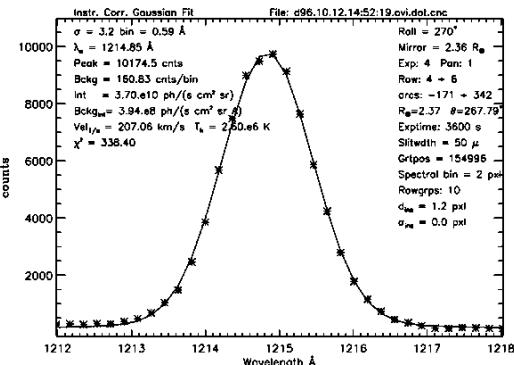
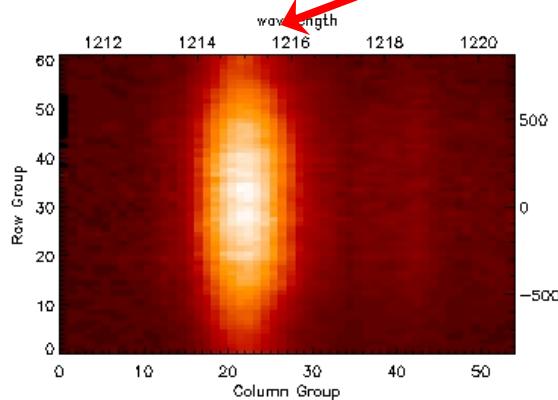
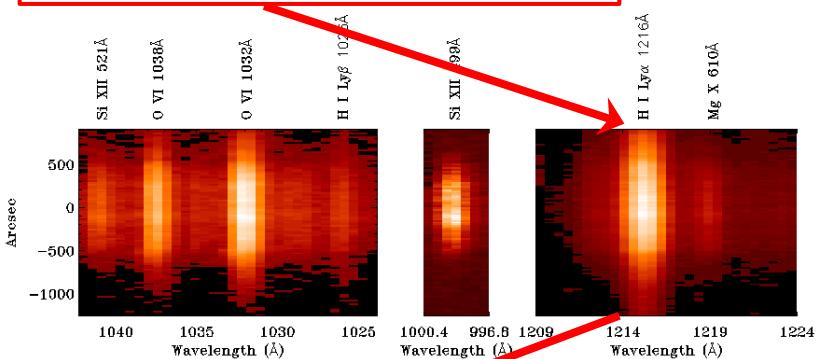
Internally and externally occulted coronagraph

Main Scientific Goals: Solar Wind Acceleration
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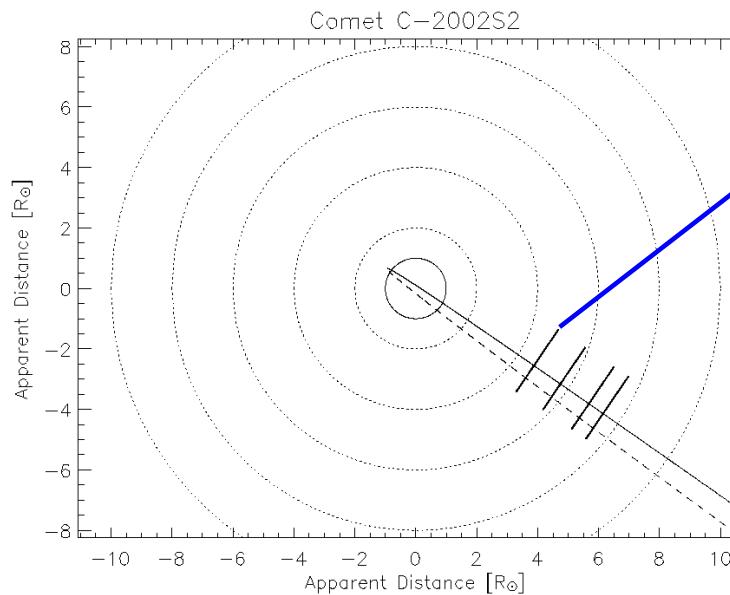
H I Ly α λ 1216Å line emission



Spectral line fit

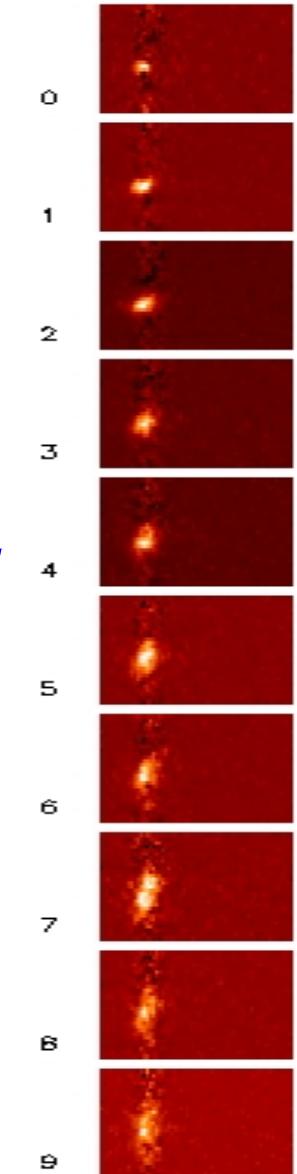
UVCS DATA

2 UV spectrometric channels
Spectral Range: ~450 to ~1350 Å

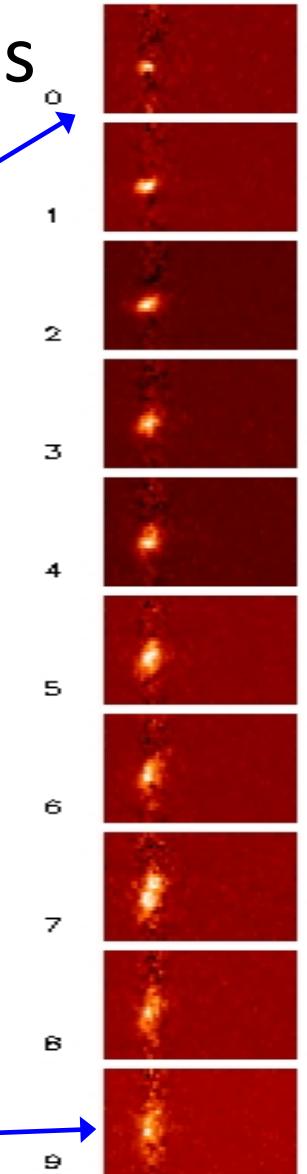
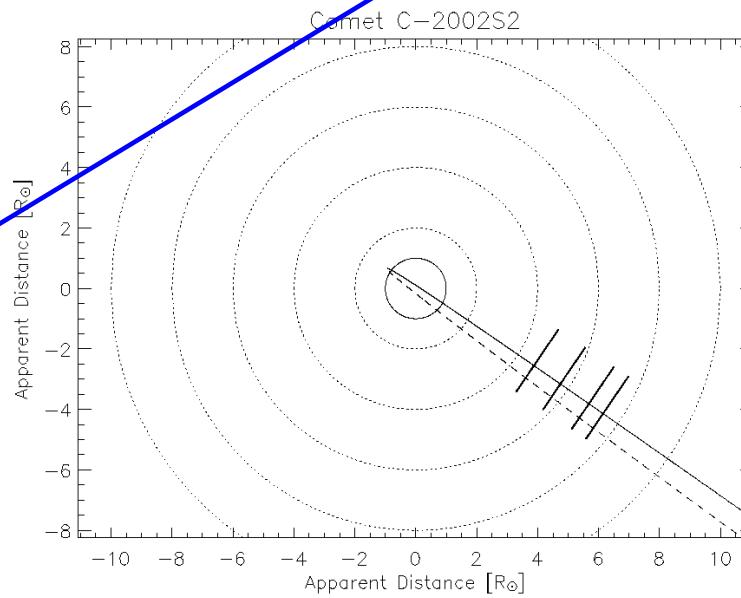
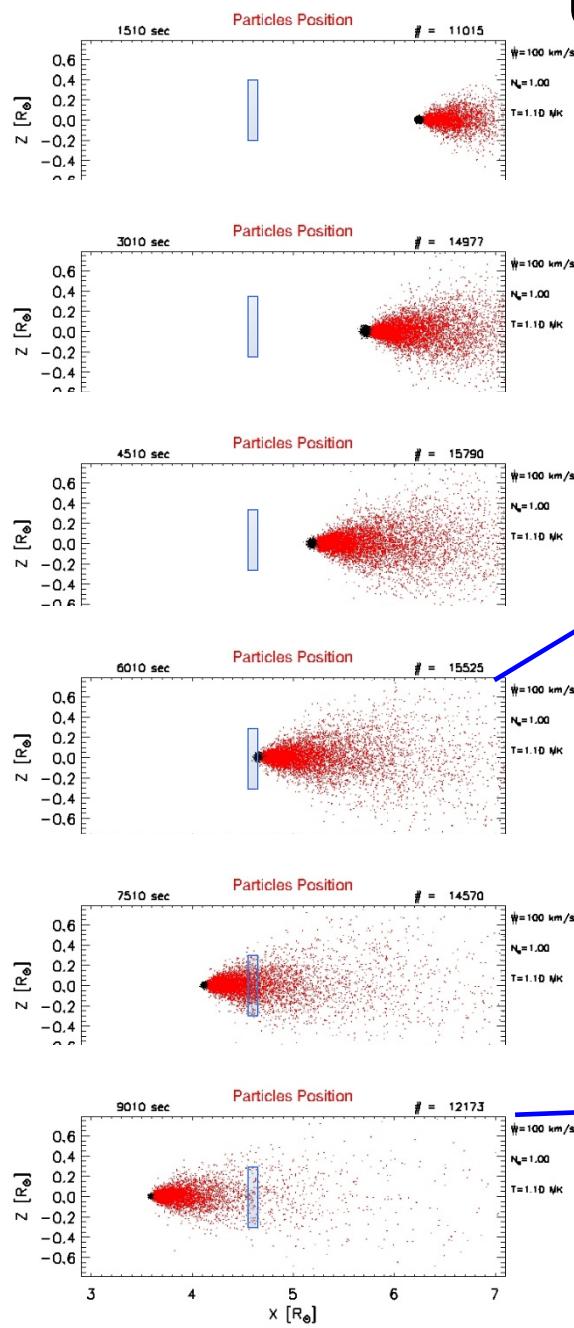


$$I_{\lambda_0} T_k$$

Sit and Stare
120 seconds exposures
detects a comet crossing the UVCS slit



UVCS Comet Observations



Sit and Stare
120 seconds exposures
detects a comet crossing the UVCS slit

UVCS Comet Observations

Date	Comet Name	Group	Height R_{\odot}	PA ccw deg	Publ.
1996 Dec 23	C/1996 Y1 SOHO-6	Kreutz	4.50 – 5.50 (2)	115	Raymond 1998
1997 May 1-2	C/1997 H2 SOHO-8		30.0		
1998 Jun 1	C/1998 K11 SOHO-55	Kreutz	2.15	260	in progress
1999 May 20	C/1999 K1 SOHO-63	Kreutz	6.36	182	
1999 Sep 17	C/1999 S1 SOHO-86	Kreutz	6.57 – 5.42 (4)	236	
2000 Feb 10	C/2000 C6 SOHO-104	Kreutz	6.43 – 3.44 (4)	105	Uzzo 2001
2000 Feb 29	C/2000 D1 SOHO-106	Kreutz	4.19 – 3.48	114	
2000 Sep 9-11	2P/ENCKE				Raymond 2002
2000 Oct 11	C/2000 T1 SOHO-204	Kreutz	8.62 – 5.71 (3)	220	
2001 Feb 6-7	C/2001 C2 SOHO-294	Kreutz	4.98 – 3.60	100	Bemporad 2005
2002 Jan 8	96/P Machholz				
2002 May 14	C/2002 J8 SOHO-442	Kreutz	7.52 – 6.26 (3)	195	
2002 Sep 18	C/2002 S2 SOHO-517	Kreutz	7.41 – 4.66 (4)	236	in progress
2003 Jan 27-29	C/2002 X5 Kudo-Fujikawa		40.0		Povich 2003
2003 May 24	C/2003 K7	Kreutz	1.87	255	Ciaravella 2010
2004 Oct 7	??2010 ??		7.0 – 4.0	239 -- 292	
2011 Dec 15	C/2011 W3 Lovejoy	Kreutz	10.0 – 2.1 (4)	100-160	Raymond 2018

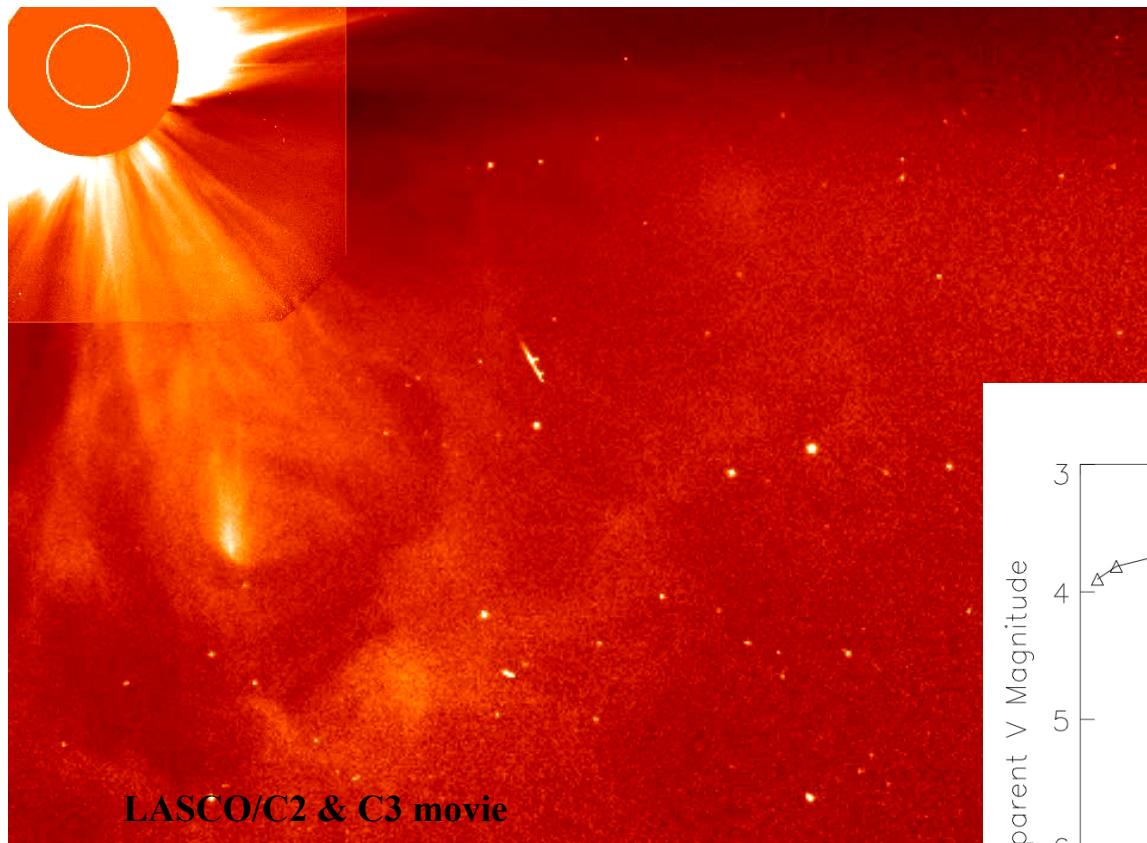
UVCS observed 17 comets: 12 Sungrazing (all Kreutz)

UVCS Comet Observations

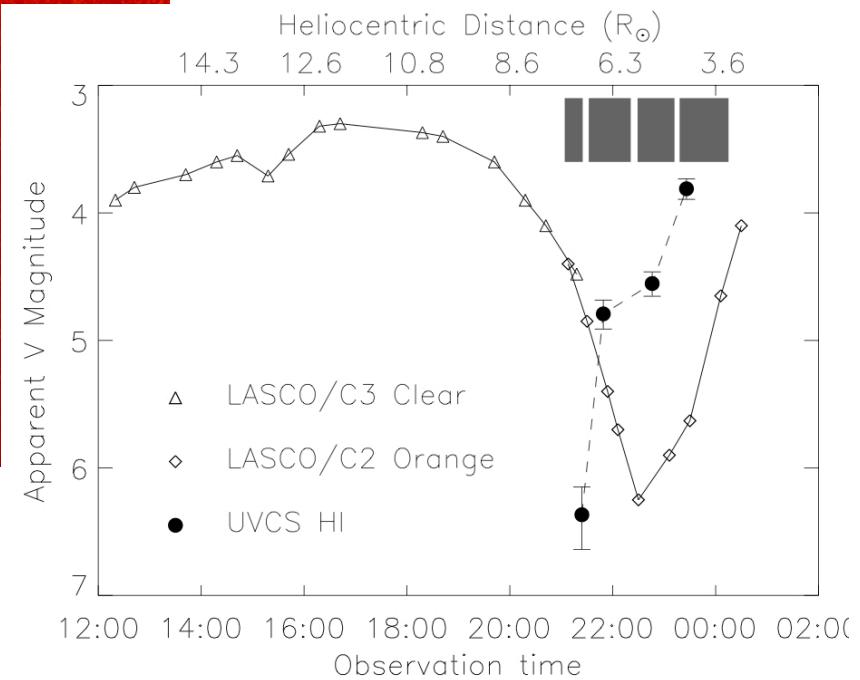
Date	Comet	Observation Details
1996 Dec 23	C/1996 R2	Initial observation
1997 May 1-2	C/1997 C1	Second observation
1998 Jun 1	C/1998 J1	Third observation
1999 May 20	C/1999 L1	Fourth observation
1999 Sep 17	C/1999 Q1	Fifth observation
2000 Feb 10	C/2000 E1	Sixth observation
2000 Feb 29	C/2000 F1	Seventh observation
2000 Sep 9-11	2000 S1	Eighth observation
2000 Oct 11	C/2000 V1	Ninth observation
2001 Feb 6-7	C/2001 A1	Tenth observation
2002 Jan 8	9P/Tuttle-Giacobini-Kreutz	Eleventh observation
2002 May 14	C/2002 D1	Twelfth observation
2002 Sep 18	C/2002 P1	Thirteenth observation
2003 Jan 27-29	C/2003 A1	Fourteenth observation
2003 May 24	C/2003 F1	Fifteenth observation
2004 Oct 7	?	Sixteenth observation
2011 Dec 15	C/2011 W1	Seventeenth observation

UVCS observed 17 comets: 12 Sungrazing (all Kreutz)

LASCO and UVCS Observation of C/2002 S2



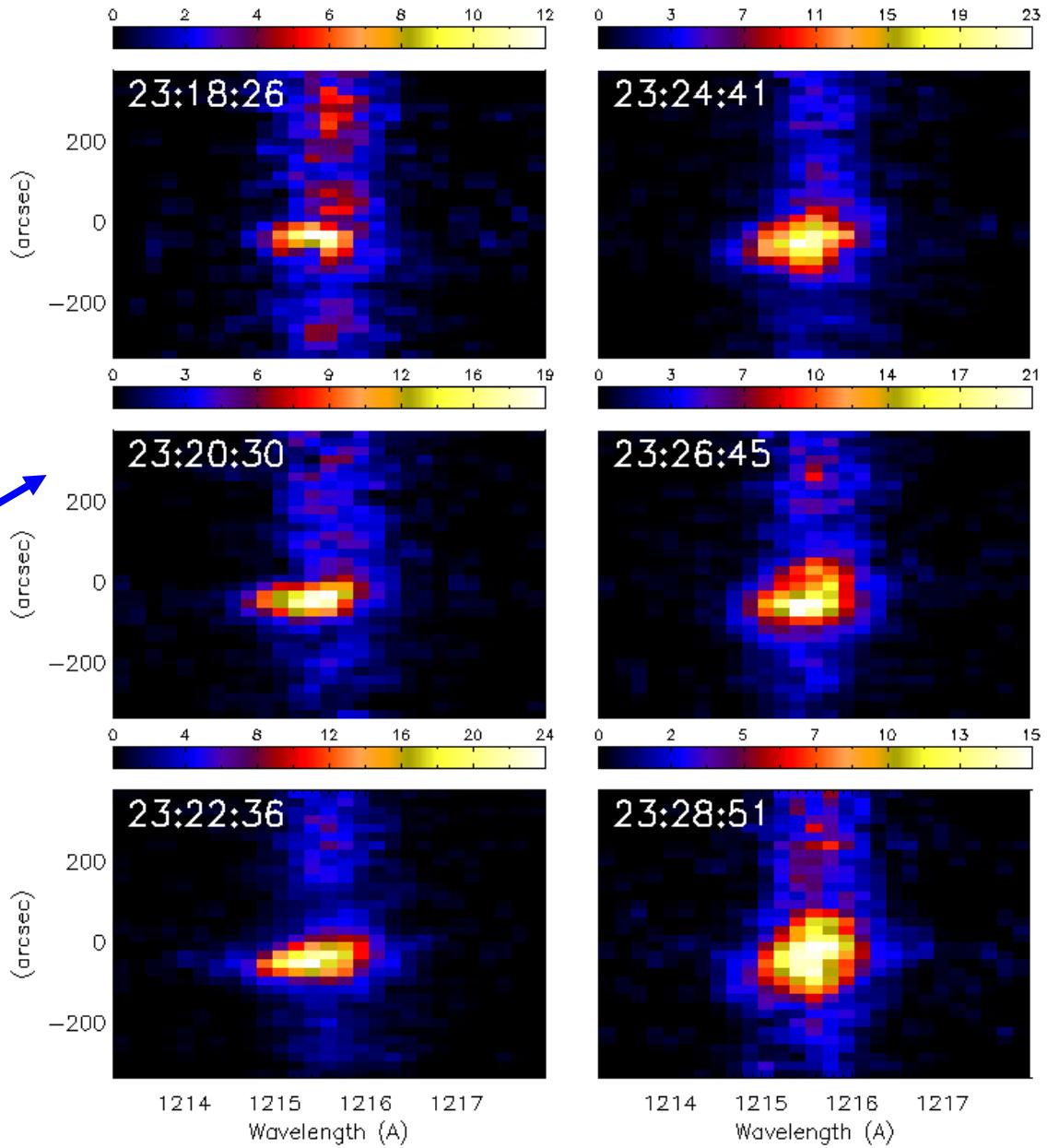
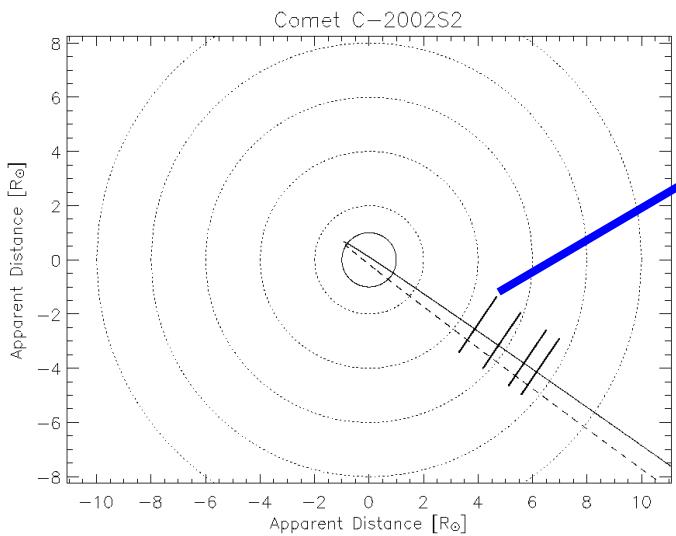
LASCO/C2 & C3 movie



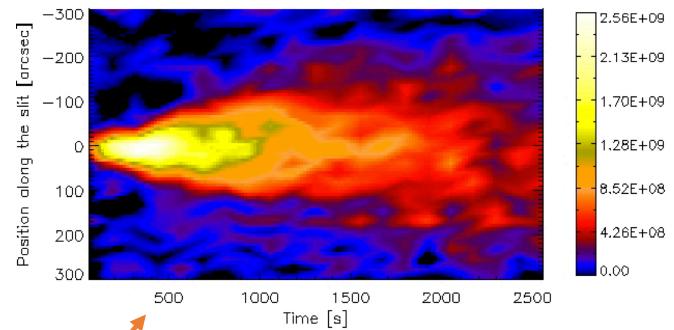
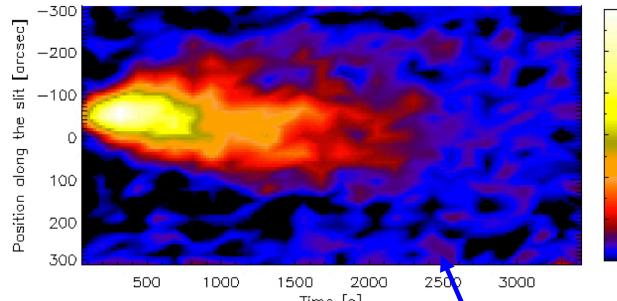
C/2002 S2 light curve shows
a **secondary brightening** below $\sim 5.7 R_{\odot}$. \rightarrow possible fragmentation

UVCS Observation of C/2002 S2

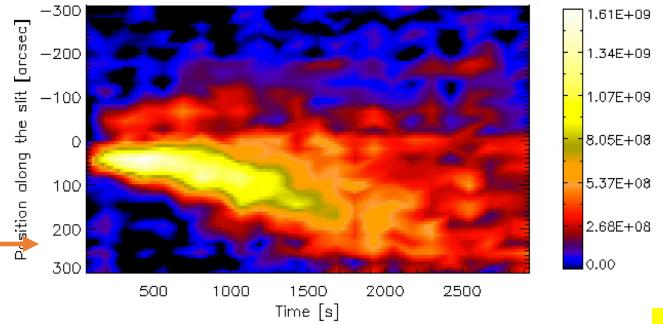
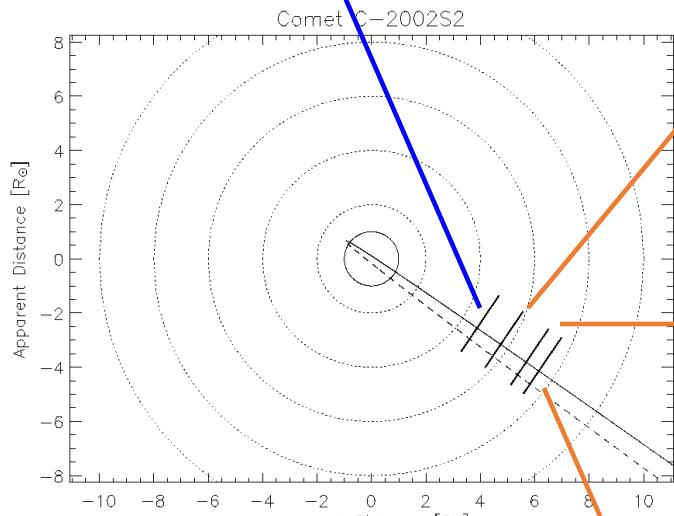
H I Ly α $\lambda 1216\text{\AA}$ line emission



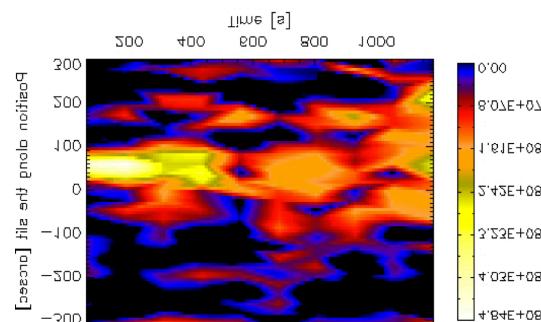
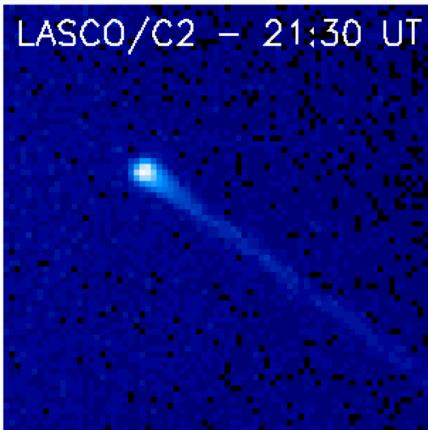
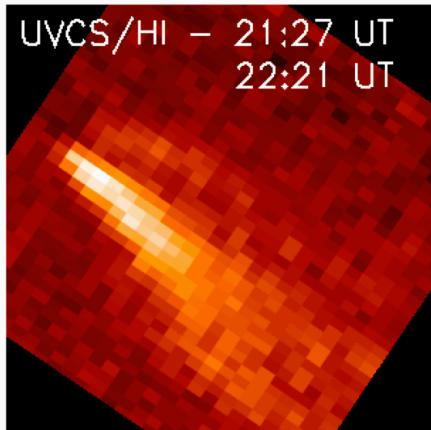
C/2002 S2 Intensity Image Reconstruction



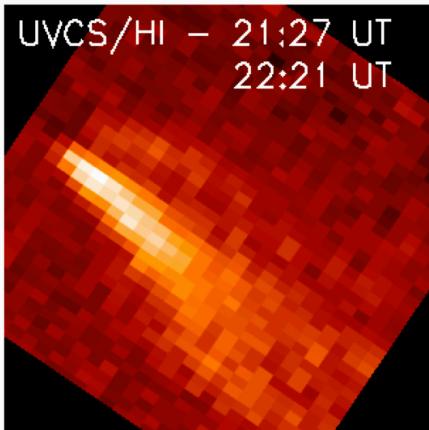
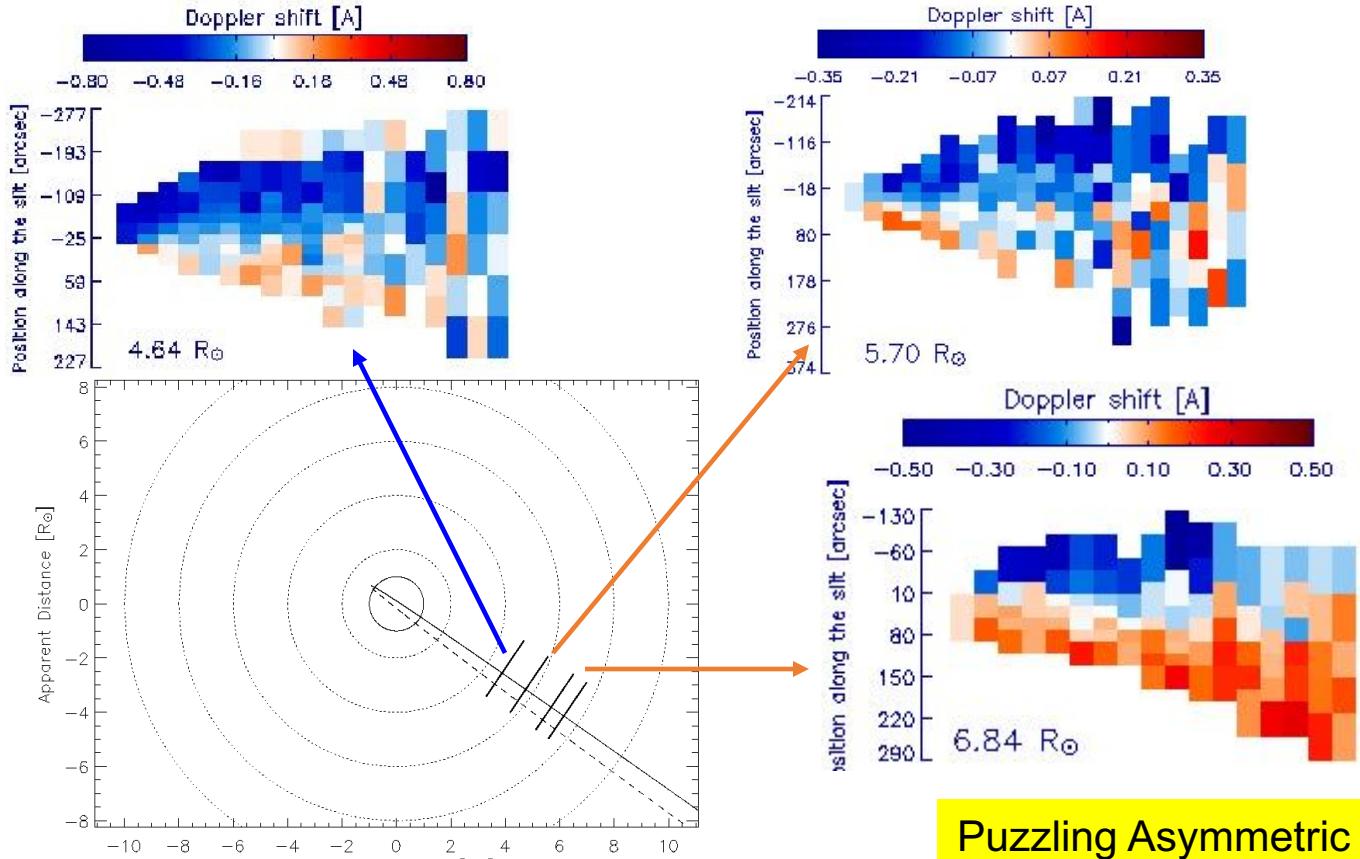
Possible two tails



Density gradient
or
Wind not radial



C/2002 S2 Velocity Image Reconstruction

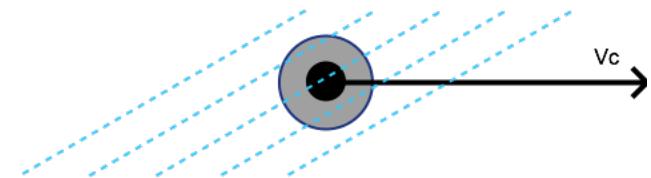


Puzzling Asymmetric
Doppler shift
(It's not Rotation)

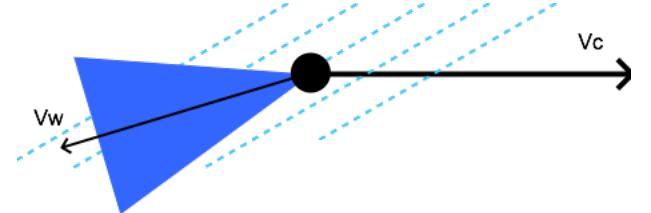
Origin of the observed H I Ly α emission

Neutral Hydrogen Generation Mechanisms

- Photodissociation $H_2O + h\nu \rightarrow O + 2H$



- Charge Transfer $H + p^+ \rightarrow p^+ + H$



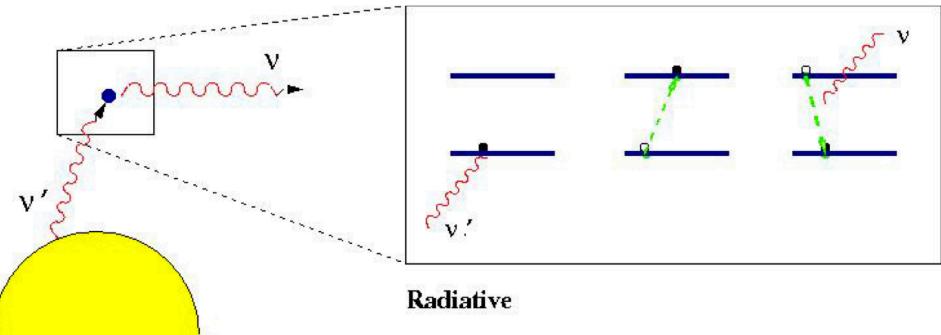
Neutral Hydrogen Destruction Mechanisms

- Collisional Ionization $H + e^- \rightarrow p^+ + 2e^-$

- Photoionization $H + h\nu \rightarrow p^+ + e^-$

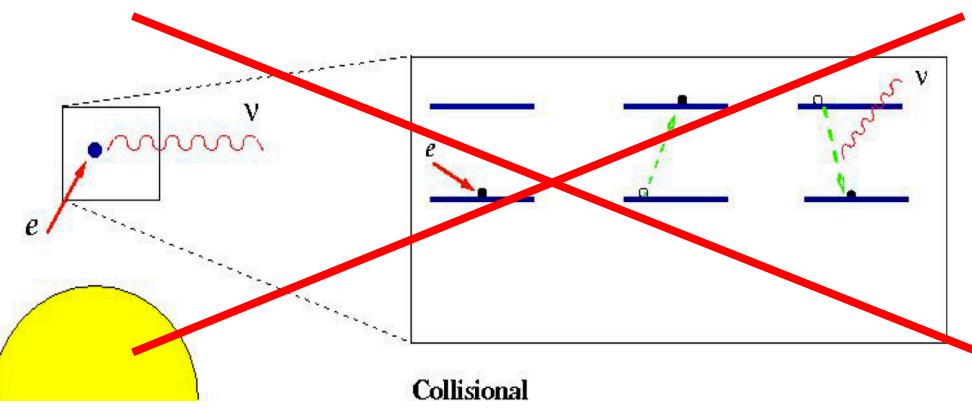
Excitation Mechanisms

- Photoexcitation from chromospheric radiation



Radiative

- Collisional Excitation with electrons



Collisional

Kinetic Simulation of H I Ly α emission

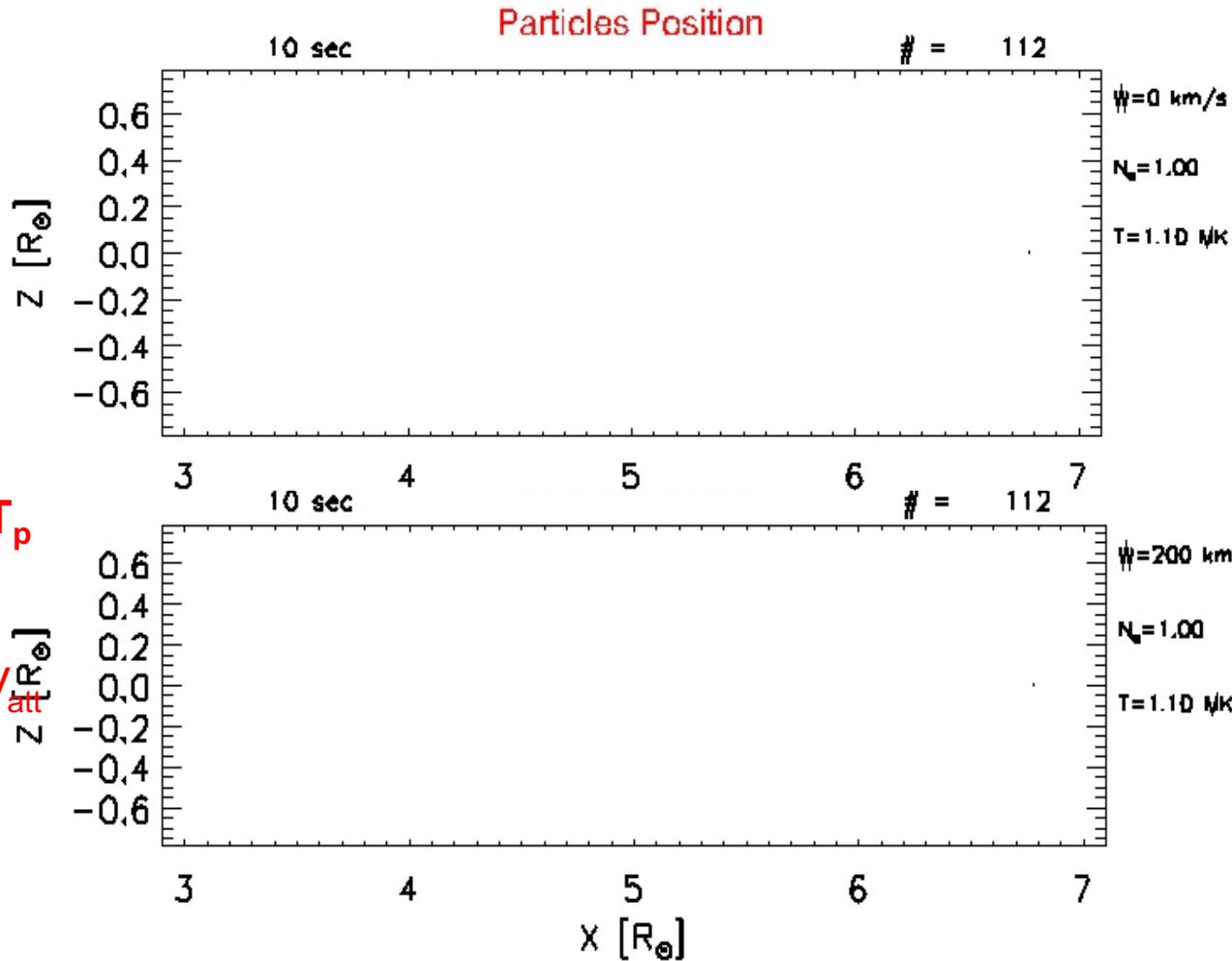
Numerical kinetic simulations (Monte Carlo)
by assuming different coronal and cometary parameters

physical processes:

- Ionization
- Charge Transfer
- Resonant scattering
- Optical Depth (V_{att})

input parameters:

- coronal model: n_e , v_{wind} , T_p
- comet kinematics
- outgassing rate: $N_{\dot{e}}$
- H cloud expanding speed: V_{att}



→ output: H I Ly α spectra as a function of time → images → light curves

→ observation/simulation comparison: χ^2 (n_e , v_{wind} , T_k , $N_{\dot{e}}$, V_{att})

Simulation of the observed H I Ly α emission

Numerical kinetic simulations (Monte Carlo) by assuming different coronal and comet

physical processes:

- Ionization
- Charge Transfer
- Resonant scattering
- Optical Depth (V_{att})

input parameters:

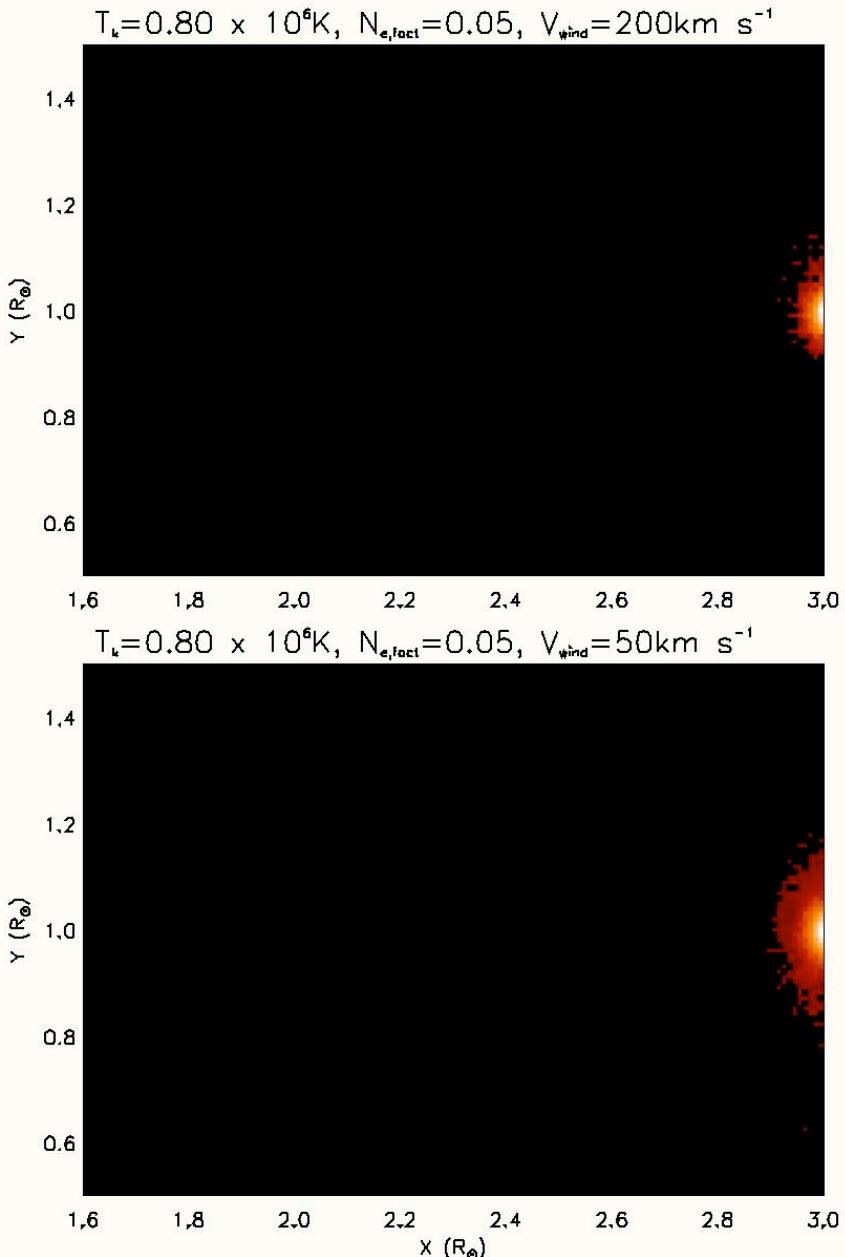
- coronal model: n_e , v_{wind} , T_p
- comet kinematics
- outgassing rate: N_{dot}
- H cloud expanding speed: V_{att}

→ output: H I Ly α spectra

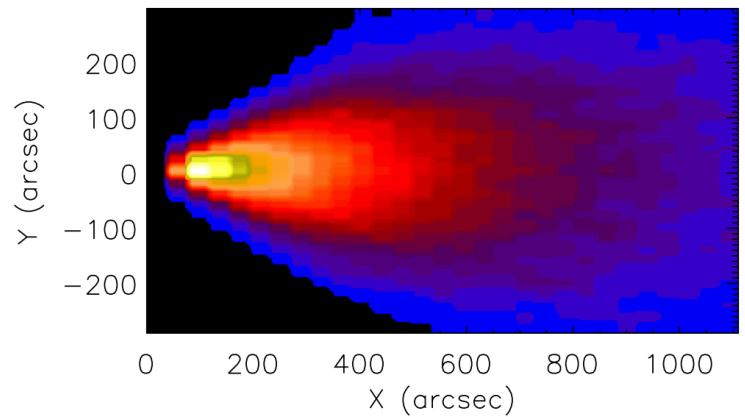
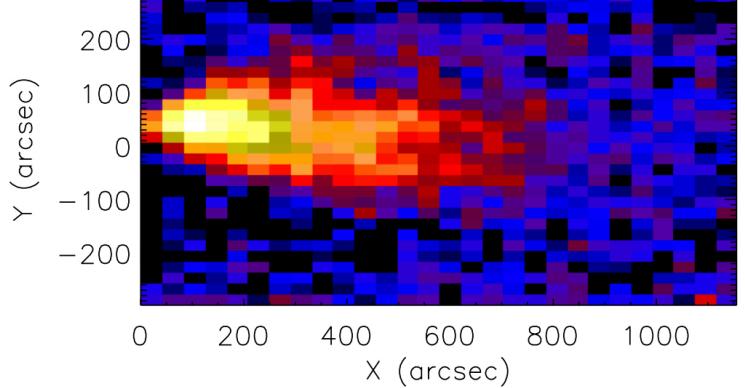
 → images → light curves

→ observation/simulation

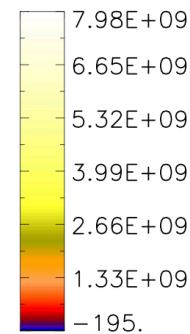
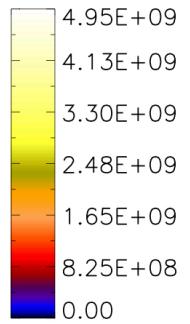
comparison: χ^2 (n_e , v_{wind} , T_k , N_{dot} , V_{att})



Sungrazing comets H I Ly α simulation: some results

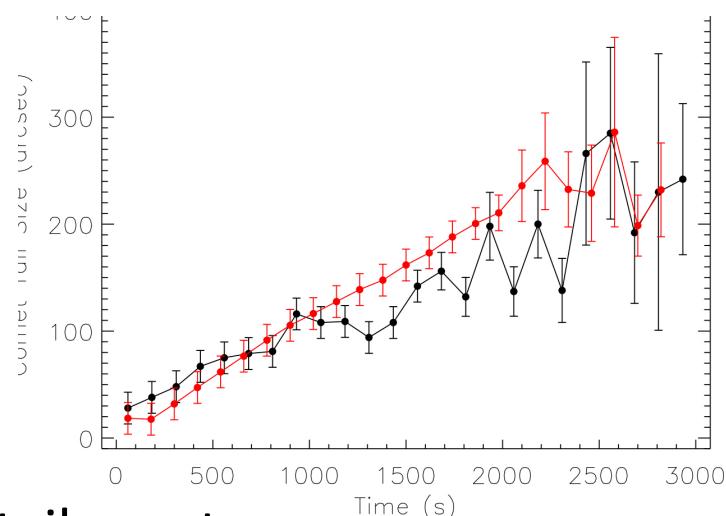
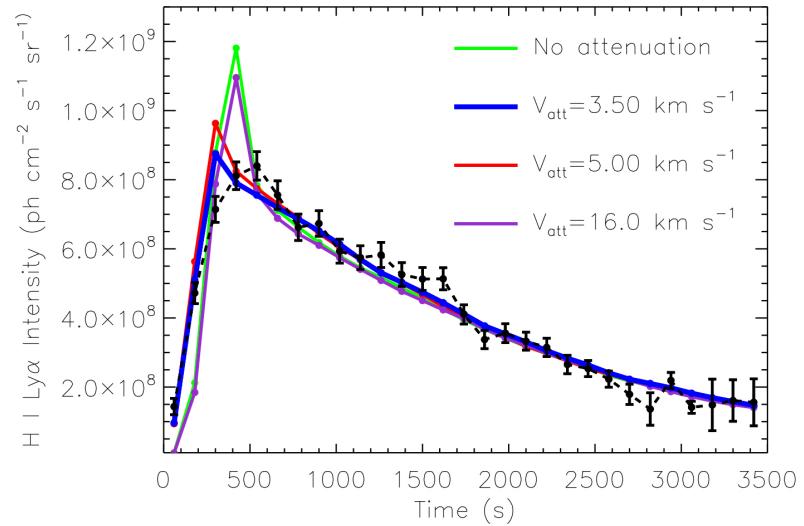


H I Ly α brightness



H I Ly α tail aperture

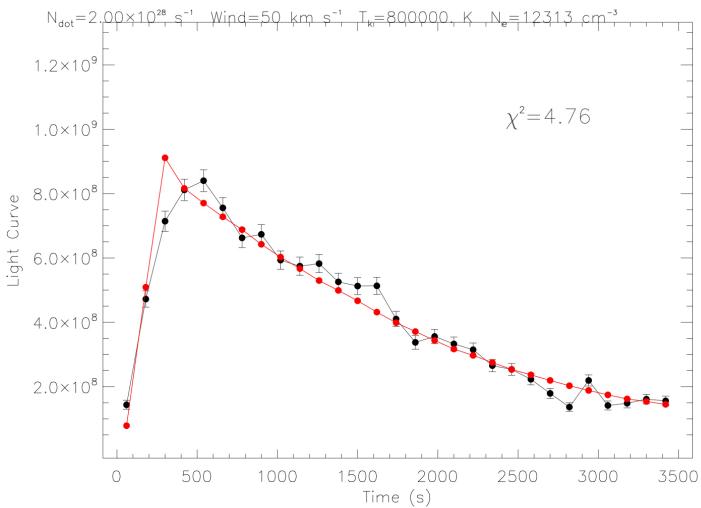
H I Ly α light curve



UVCS Sungrazing Comets Results (some)

Outgassing Rate and Nucleus Size

From the observed $F_{\text{Ly}\alpha}(t)$ (exponential decay) → cometary **outgassing rate** and the local plasma electron density n_e



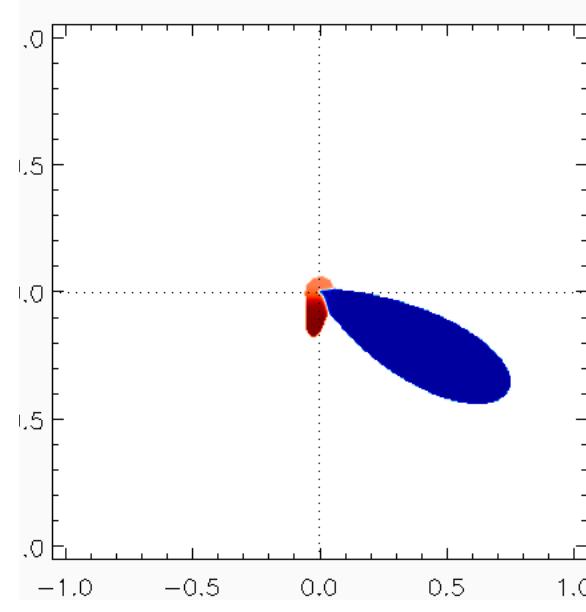
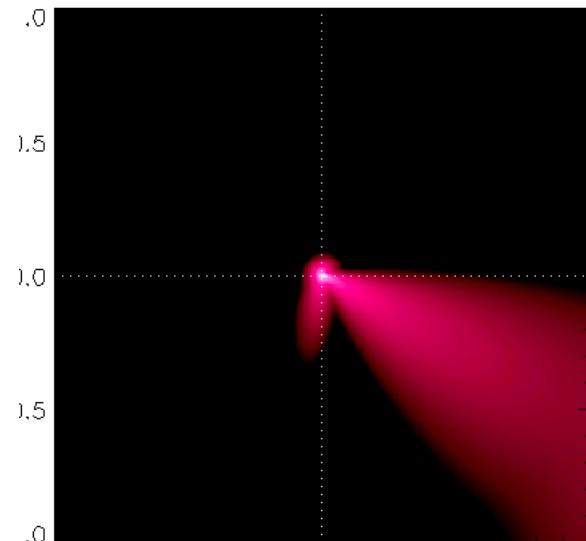
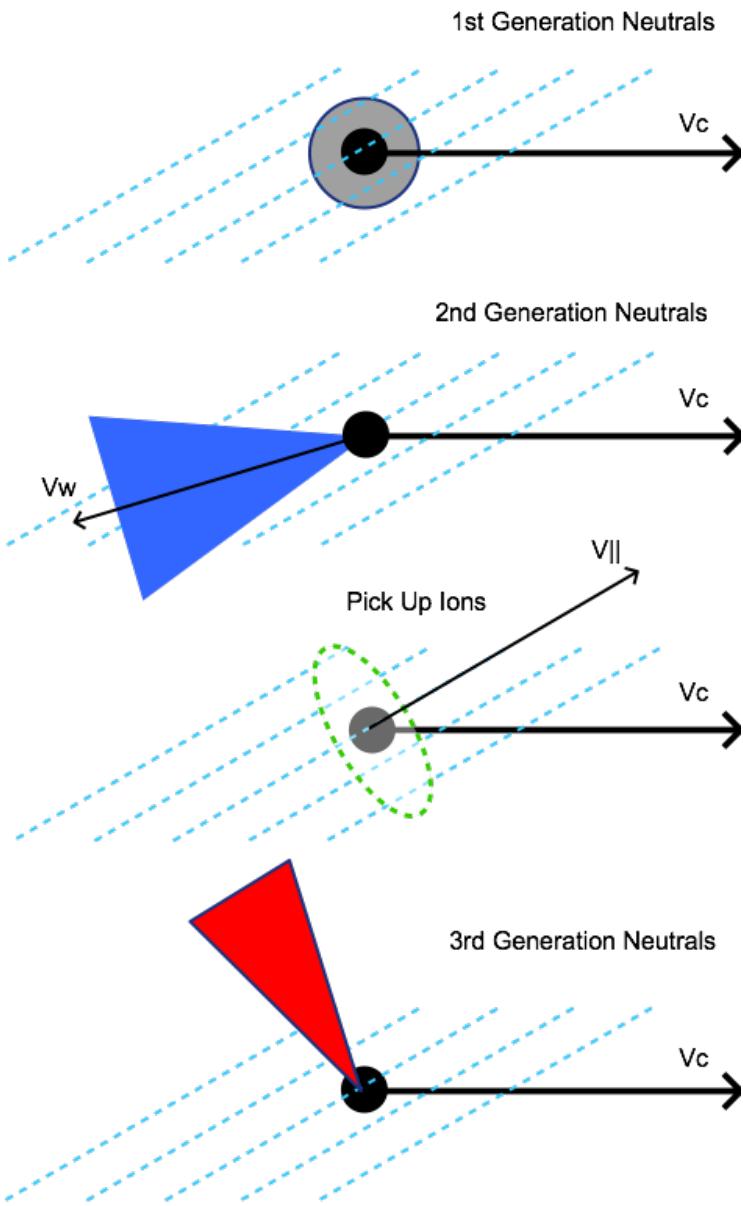
- **H₂O production rates**
 $Q_{H_2O} \sim 10 - 6000 \text{ kg/s}$
- **Nucleus sizes**
radius $\sim 3 - 60 \text{ m}$

Many fragments ?

Assuming a spherical nucleus
and isotropic outgassing we
estimate its **equivalent radius**

Comet Name	Q_{H_2O} (kg/s)	r (m)	h (R_o)
C/1996 Y	20.0	3.4	6.80
C/2000 C6	71.8	3.0	3.26
	140.0	5.8	4.56
	34.6	3.4	5.71
	10.5	2.5	6.36
C/2001 C2	820.0	20.3	3.60
C/2003 K7	6000.0	60.0	3.37
C/1998 K11	2000.0	17.0	2.90
C/2002 S2	300.0	8.0	5.99
C /2011 W3		386.0	2.00
		383.0	5.70
		480.0	6.92

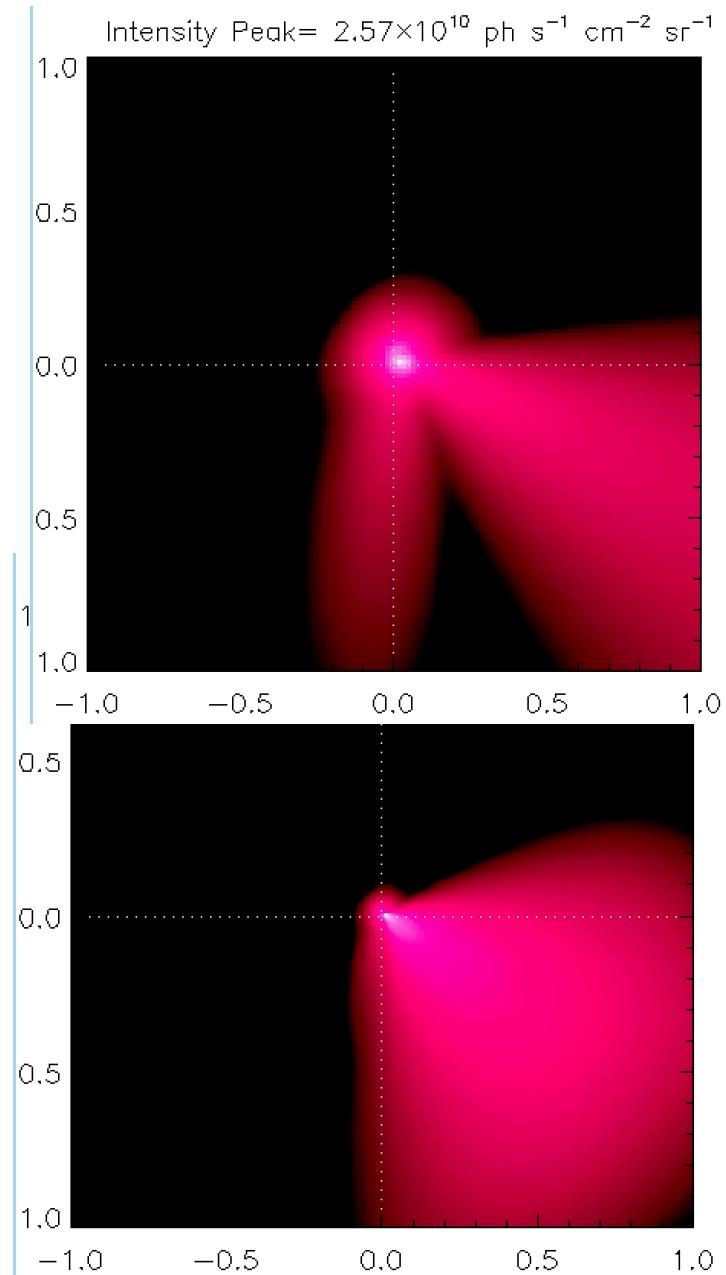
Magneto-Hydro-Dynamic Simulation of H I Ly α emission



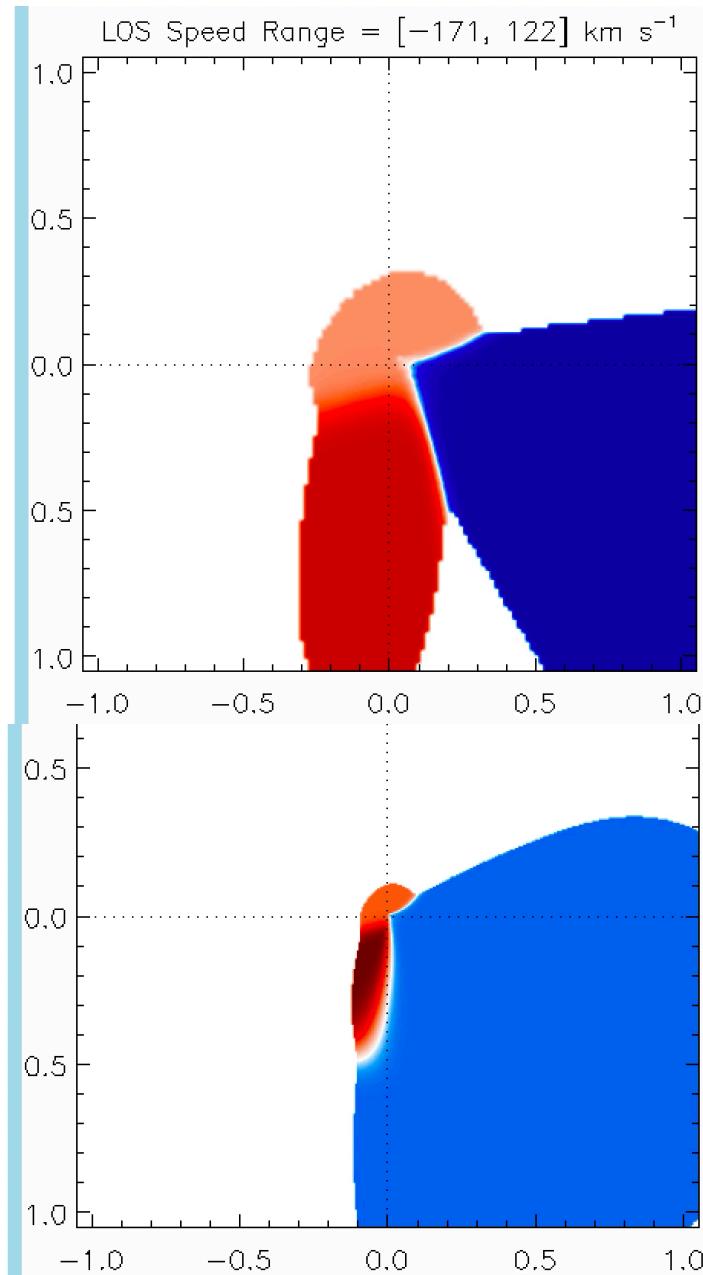
MHD Simulation of H I Ly α emission

In funzione di

- Densità Corona

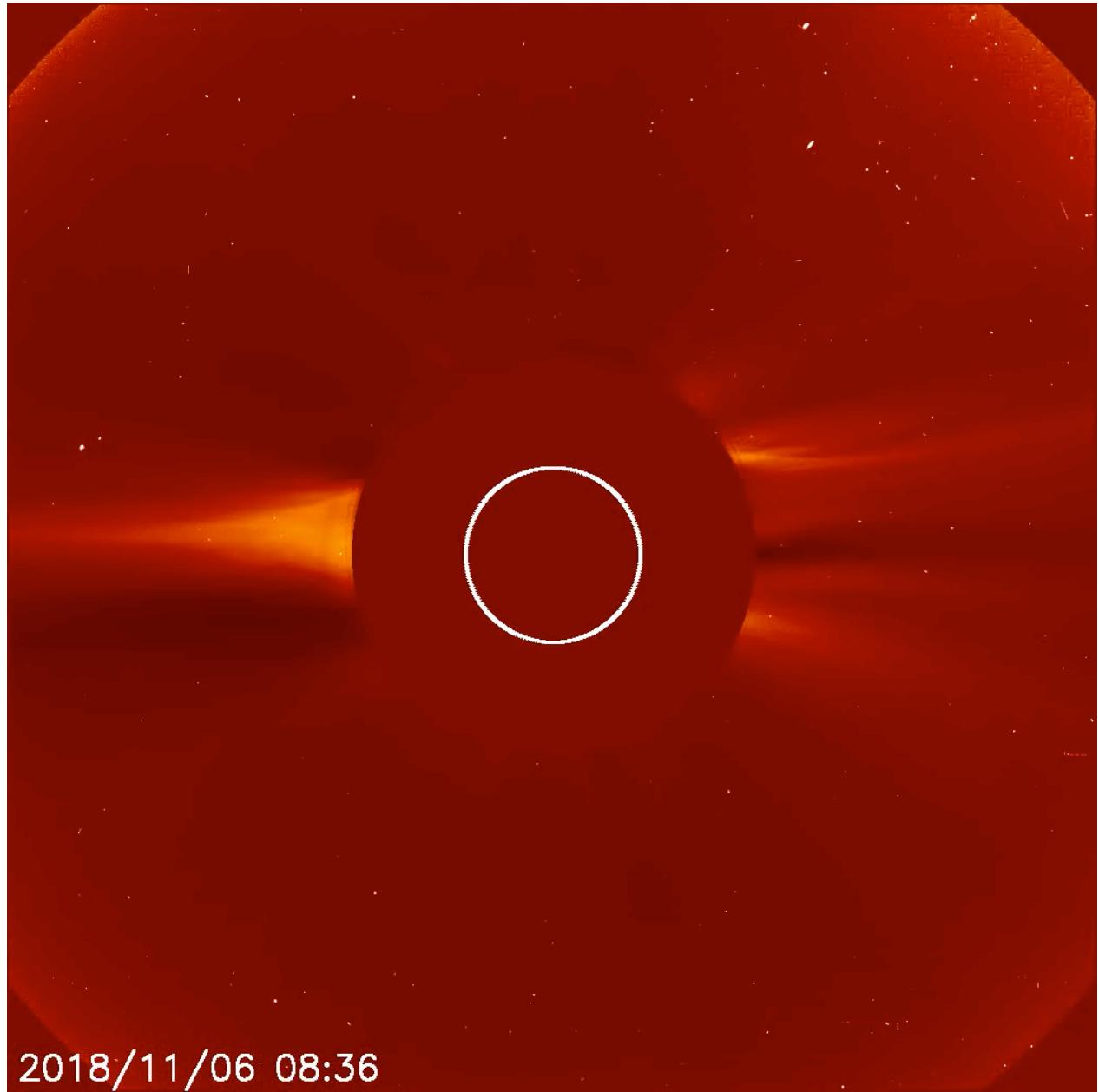


- Velocità Vento Solare



A caccia di Comete

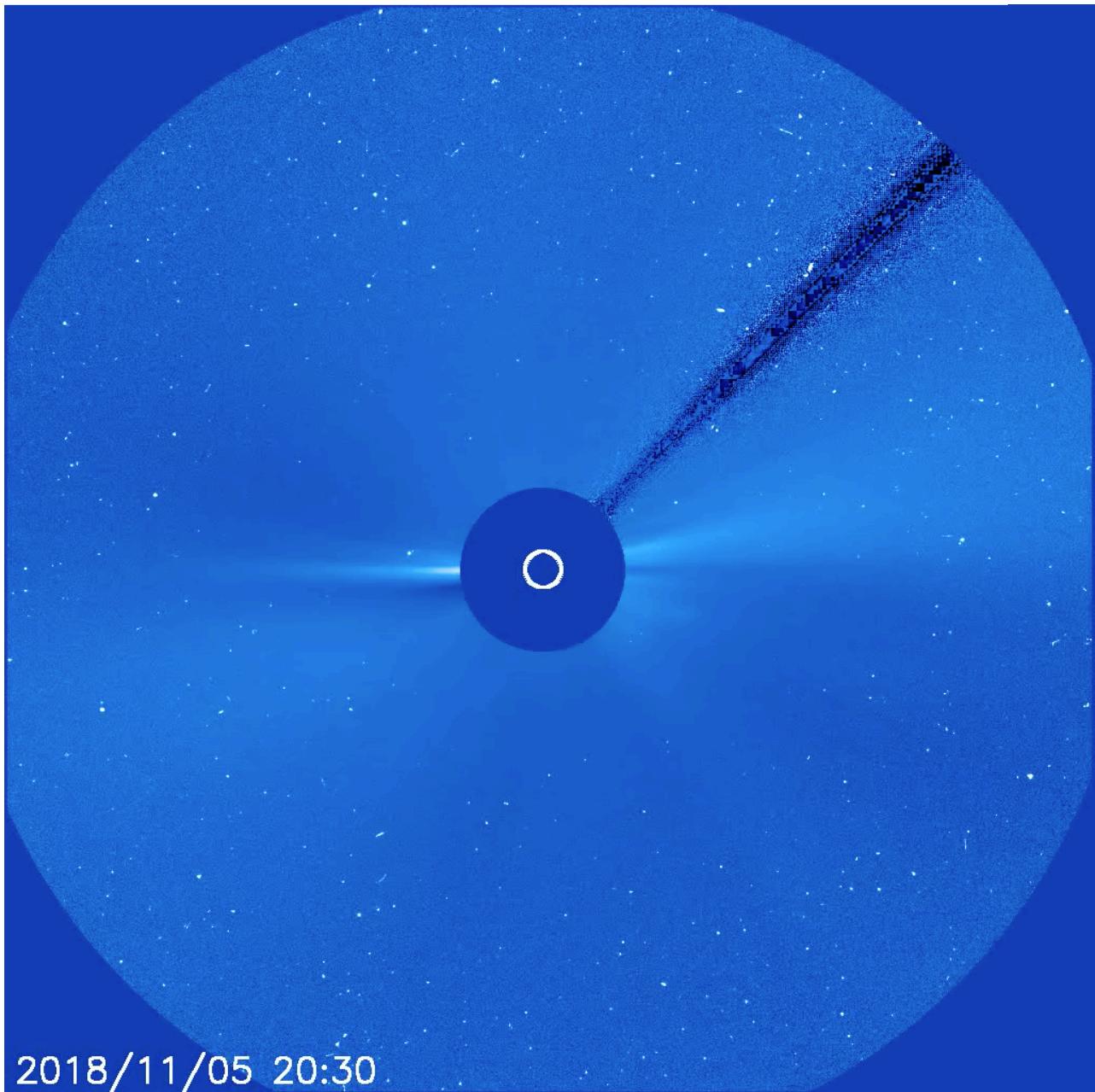
La corona solare
negli ultimi 4 giorni



2018/11/06 08:36

A caccia di Comete

La corona solare
negli ultimi 4 giorni



A caccia di Comete

<https://sungrazer.nrl.navy.mil/index.php?p=guide>

The banner features a blue header with the text "Sungrazer Project" in white. Above the text are five small square images of comets. Below the text are three more small square images of comets. At the bottom of the banner are several navigation links: "NRL" with a logo, "LASCO Homepage" with a logo, "SECCHI Homepage" with a logo, and "Sungrazer Home" with a logo.

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The "Official Guide" to SOHO Comet Hunting

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Introduction to the guide

Over 1800 comets have been discovered within images taken by the joint ESA/NASA mission called "SOHO" (Solar and Heliospheric Observatory"). The overwhelming majority of these comets have been found by amateur astronomers and enthusiasts around the world who download the latest satellite data from the Internet and search the images for signs of a comet.

The following guide is primarily designed to help newcomers find their first SOHO comet. It describes the features visible in the images such as stars, planets and cosmic rays (those that are most often mistaken for comets), as well as the comets themselves. Also included is information on how to report comets, how to check if your report is likely to be real or not, and miscellaneous hints and tips on how and when to look for comets in the images. At the end of the guide there are some example data sets that can be downloaded and used to hunt for previously-discovered Kreutz-group comets.

Nearly all (over 99%) of SOHO's comet discoveries have been made in images from the [LASCO](#) coronagraph instrument on-board SOHO. LASCO is a set of two telescopes (actually three, but one is no longer operational) -- "C2" and "C3" -- that are specially designed to study the solar atmosphere by blocking out direct sunlight via the use of a "occulting disk" that creates a constant eclipse for the