# Coronal Observations at the Siberian 2008 Total Solar Eclipse

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**Abstract.** We successfully observed the 1 August 2008 total solar eclipse from the rooftop observatory of the State University of Novosibirsk in Akademgorodok, Siberia, latitude 55° N at 10:45 UT in clear skies and also from an airplane at 83° N latitude north of Svalbard at 9:43 UT. Our prime experiment in Akademgorodok was a set of high-cadence, 10 Hz, observations in the coronal green line at 530.3 nm from [Fe XIV] to verify and extend our previous findings of excess power in the 0.5 Hz to 1 Hz region as predicted by a subset of coronal-heating theories. We used twin 0.2-m telescopes with narrow-band interference filters and our POETS frame-transfer CCD's on the university's Paramount ME. Additional photography included graded-exposure sets of images meant for post-processing to compare with images taken earlier from the airplane and later from the ground in Mongolia and China to provide time differences of over 90 minutes. We also obtained HD video. Our comparison of the images from the airplane and from Siberia will be used to search for coronal motions.

We observed the total solar eclipse of 1 August 2008 from Akademgorodok, an academic city 20 km outside the Siberian city of Novosibirsk, the third largest city in Russia. We chose the site because of the facilities available to us at the State University of Novosibirsk. Our group, largely from Williams College, worked there in conjunction with Alphya Nesterenko, head of their laser and spectroscopy laboratory, and Igor Nesterenko of the Russian Academy of Science's Budker Institute of Nuclear Physics.

We were joined by colleagues from the Aristotle University of Thessaloniki, Greece, and the University of Sydney, Australia.

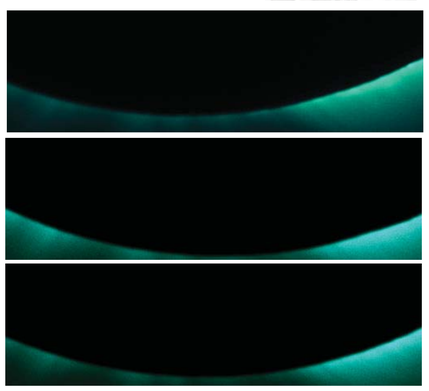
People from 20 countries watched the eclipse broadcast from our site in Akademgorodok, with 3 terabytes of information sent by Igor Nesterenko and Zolotarev Vitalii.

En route from Williams College to Novosibirsk, we spent a day in Moscow. Left to right: Jay Pasachoff, Naomi Pasachoff, Bill Wagner, Phyllis Babcock, Helen Robinson, Bryce Babcock, Linda Wagner, Paul Rosenthal, Katie DuPré, Marcus Freeman, and Rob Lucas.

## Oscillation Experiment

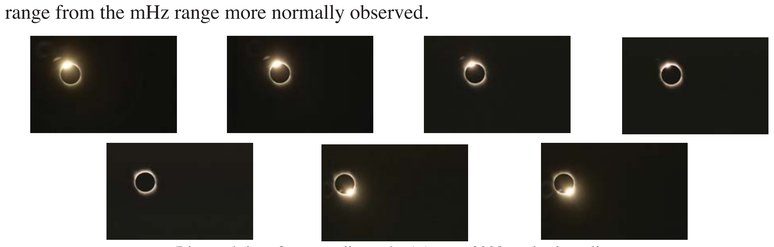
We continued our work on studying short-period oscillations, taking observations for three minutes around 10:45 UT at 10 Hz in order to be able to detect oscillations in the 1 Hz range. In previous work, we had detected excess Fourier power in the 0.5 to 2 Hz range (Jay M. Pasachoff, Bryce A. Babcock, Kevin D. Russell, and Daniel B. Seaton 2002, "Short-Period Waves that Heat the Corona Detected at the 1999 Eclipse," *Solar Physics* **207**, 241-257. www.arxiv.org: astro-ph 0202237).

We deployed two of our Portable Oscillation, Eclipse, and Transit Telescopes (POETS), one for the coronal green line at 5303 Å from [Fe XIV] and one for the coronal red line at 6374 Å from [Fe X]. (This frame-transfer CCD system is described in Steven P. Souza, Bryce A. Babcock, Jay M. Pasachoff, Amanda A. S. Gulbis, James L. Elliot, Michael J. Person, and Joseph W. Gangestad, 2006, "POETS: Portable Occultation, Eclipse, and Transit System," *Publ. Astron. Soc. Pacific* **118**, 1550-1557). We used the Paramount ME of the State University of Novosibirsk with a plate carrying our twin 20-cm Celestron telescopes, with their carbon-fiber bodies minimizing focus changes resulting from the eclipse's cooling of the atmosphere. Our spectrographic on-site monitoring before the event showed an uncertainty in the wavelength calibration of the red line filter, so we operated it off-band to provide a monitor for atmospheric and instrumental seeing and jitter. Both cameras operated well during the eclipse; however, we are addressing a software problem that has prevented accessing the complete red data sequence.

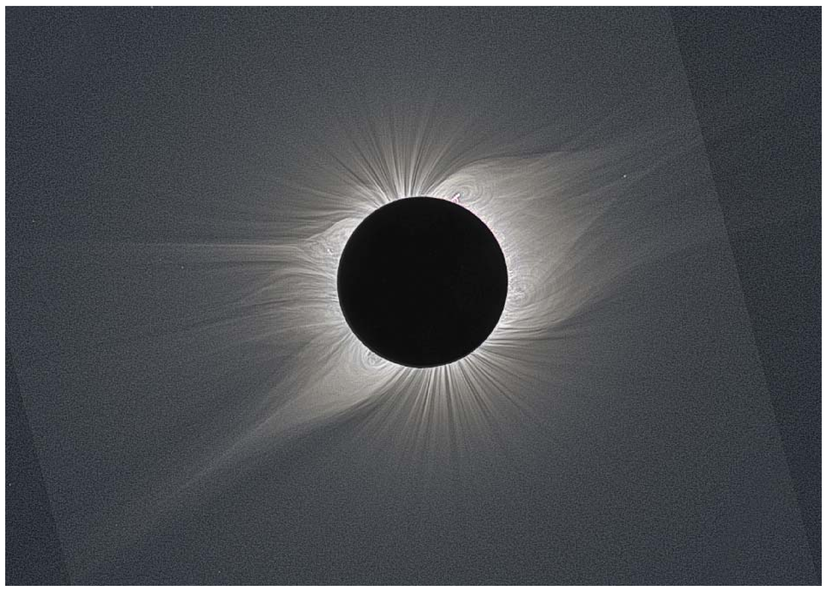


These three frames represent green-line images at roughly 2nd contact, 1 minute later and at 2 minutes 13 secs.

Seeing conditions during the week prior to the eclipse precluded adequate alignment of the newly installed Paramount ME mount, resulting in the image drifting about 10% of the FOV during the course of the eclipse. These data are under study, with Fourier and wavelet analysis pending to search for quasiperiods. The search is part of coronal seismology, extending the temporal coverage to the 1 Hz range from the mHz range more normally observed.



Diamond rings frame totality at the 1 August 2008 total solar eclipse.
(Images by Jay Pasachoff and Jen Rosenthal, Williams College Expedition)

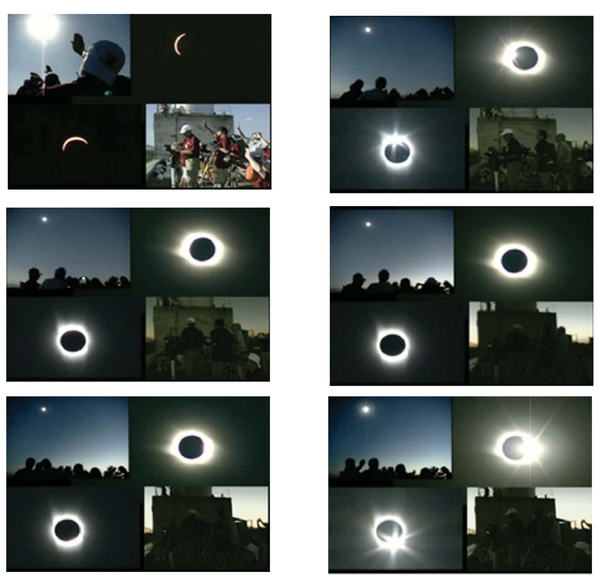


Williams College Expedition: Jay M. Pasachoff, Bryce A. Babcock, William G. Wagner, Matthew Baldwin, Katherine DuPré, Marcus Freeman, Marek Demianski, and Paul Rosenthal, in collaboration with Alphya Nestorenko and Igor Nestorenko of the State University of Novosibirsk, Akademgorodok, Russia. Image processing by Haná Druckmüllerová, Brno Technical University, Czech Republic.

## Imaging observations

We observed the eclipse with a variety of coronal green-line and white-light imaging. The large image shows a composite assembled from many of our images by Haná Druckmüllerová and Miloslav Druckmüller,who combine exposures of various lengths to compensate for the wide dynamic range of the corona and to enhance the contrast. We have worked with them on previous eclipses (Jay M. Pasachoff, Shelby B. Kimmel, Miloslav Druckmüller, Vojtech Rusin, and Metod Saniga, 2006, "The 8 April 2005 Eclipse White-Light Corona," *Solar Physics* **238**, 261-270; Jay M. Pasachoff, Vojtech Rusin, Miloslav Druckmüller, and Metod Saniga, 2007, "Fine Structures in the White-Light Solar Corona at the 2006 Eclipse," *Astrophysical Journal*, **665**, 824).

In particular, at the 2006 eclipse, we detected motion in a solar plume by comparing data from eclipse sites in Africa, with data from sites in Greece and Turkey (Jay M. Pasachoff, Vojtech Rusin, Miloslav Druckmüller, Haná Druckmüllerová, Marcel Bělík, Metod Saniga, Milan Minarovjech, Eva Markova, Bryce A. Babcock, Steven P. Souza, and Jesse S. Levitt, 2008, "Polar Plume Brightening During the 29 March 2006 Total Eclipse," *Astrophysical Journal*, **682**, 638). We intend to carry out such comparisons again, especially for the comparably resolved data from Siberia and from Mongolia, a time difference of about 30 minutes in the progress of totality. Many differences in the corona have already been viewed in preliminary comparisons.



Six sets, each of four video images, one pair within the four showing part of the team during the eclipse and the coronal/diamond-ring image simultaneously in HD, and the other pair showing similar subjects in VHS. (Images by Paul Rosenthal and Michael Kentarianakis, with the Williams College Expedition, assembled by Michael Kentarianakis. The video is available on YouTube: http://www.youtube.com/watch?v=jDHR3pyoEUI)

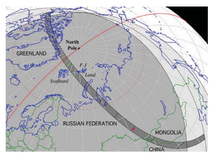
## Aircraft observations

Coauthor Glenn Schneider organized a chartered jet to fly from Germany into the eclipse path north of Svalbard, at latitude 83° north at 9:43 UT. As we had in the 2003 Antarctic flight, we used a platform steadied by perpendicular gyros and carrying four still and video cameras.

The data were not of the same quality as the ground-based data because of tracking and jitter, and because they were taken through an aircraft cockpit window. Still, combinging the high-latitude airborne, and lower latitude ground-based images provides a temporal baseline of over 90 minutes to study temporal variations in the corona.



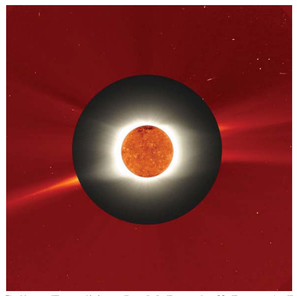
http://nicmosis.as.arizona.edu:8000/ECLIPSE_WEB/ECLIPSE_08/TSE2008_FLIGHT_FD/TSE2008_FLIGHT_DECK_SETUP.html



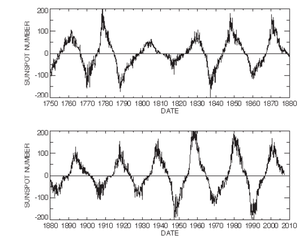

Akademgorodok: red dot; airplane at 83° N: green dot.

## Comparison with spacecraft observations

As we have before, we provided our eclipse images to fill in the gap in the coverage of the sun that exists on a daily basis because the coronagraphs on the SOHO and STEREO missions have to overocculcult the solar photosphere because of its extreme brightness. With Extreme-ultraviolet Imaging Telescope (EIT) images showing the solar disk and Large-Angle Spectroscopic Coronagraph (LASCO) images showing the outermost corona, only on the days of eclipses can one follow the whole range of coronal streamers, from their roots on the surface of the sun (given that only the side facing us shows, except for STEREO's views around to the back side) through the lower corona, where the solar wind is formed, and onto the upper corona, where streamers extend far into interplanetary space.



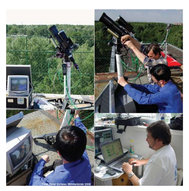
Williams College Expedition: Jay M. Pasachoff, Bryce A. Babcock, William G. Wagner, Matthew Baldwin, Katherine DuPré, Marcus Freeman, Marek Demianski, and Paul Rosenthal, in collaboration with Alphya Nestorenko and Igor Nestorenko of the State University of Novosibirsk, Akademgorodok, Russia. Inner image by EIT Team, NASA's Goddard Space Flight Center. Outer image by LASCO Team, Naval Research Laboratory. Combination by Steele Hill, NASA's GSFC with Jay Pasachoff, Williams College. SOHO is a joint project of ESA and NASA.



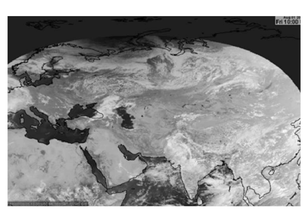

The eclipse occurred at minimum of the solar-activity cycle. (Data from Solar Influences Data Center, Royal Astronomy of Belgium; graph by David Hathaway, NASA's Marshall Space Flight Center)

Baily's beads and the solar chromosphere show at the beginning of the eclipse. (Williams College Expedition)

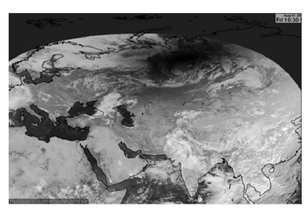
A prominence shows during the eclipse.
(Williams College Expedition)



Novosibirsk State University's Webcast



Meteosat-8 image (EUMETSAT).



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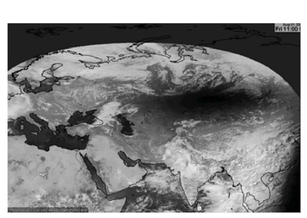

Meteosat-8 image (EUMETSAT).

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## Acknowledgments:

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