Broadband Spectroscopy during the Total Solar Eclipse of March 29, 2006

Sarah Jaeggli Made possible by S. Habbal, J. Kuhn, and the IfA Eclipse Team

Why study the solar corona?

- To study the interaction between a star and its local environment
- We are located in the solar backyard
 - Bright
 - Close

Why Eclipses?

Instrumental scattering(typical)

- A high daytime sky brightness makes it difficult to see the solar corona
 - The inner corona is bright enough to be seen with a coronagraph out to 1.2-2.0 Rsun
- During an eclipse the sky dims by three orders of magnitude
 - A large portion of the local solar environment becomes accessible for observation



ig. 1. The visible brightness of the solar corona in the equatorial plane of the Sun as a function of elongation. Observations: Blackwell (1955); Allen (1956); Waldmeier (1961); Gillett et al. (1964); Blackwell and Petford (1966a); MacQueen et al. (1973); Leinert et al. (1974); Saito et al. (1977); Dürst (1982); Nikolsky et al. (1983); Levasseur-Regourd (1996).

What can we see when the sun goes away?

- K(kontinuum) Corona, I-2.5 R_{sun}, Electron scattered disk light, very spectrally smooth
- E(emission) Corona, Emission lines from very hot species many times ionized(Fe, Mg, Ni, Ca)
- F(Fraunhofer) Corona, 2.5 R_{sun}+, Light from the solar disk scattered from zodiacal dust and cometary fragments near the sun

Eclipse site near Waw an Namus, Libya 24°33'58.2" N; 17°17' 16.3" E elevation, 439 m



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Pointer 24°38'14.17" N 17°33'39.74" E elev 443 m Streaming ||||||||| 100%



Eye alt 109.37 km

The Instrument

- QE 65000 Ocean Optics spectrograph 350-1120 nm
- 6" fast collecting mirror, masked to 0.05" for bright solar disk observations
- 36 member fiber bundle
- Digital video to record the fiber position



Eclipse Observations

Totality: 4m 6s

Position 2 ~20 observations 10 s integrations Position I ~400 observations 100 ms integrations









Instrument Limitations

- Emission lines double and shift in wavelength, caused by a wide spectrograph slit and smaller fibers
- A blue color excess appears when comparing unmasked (corona, sky) to masked (solar disk) data, due to focal ratio differences

Coronal Color: Comparison with dust models



 The model agrees with these observations within the calculated error but gives no information about the change in slope at 800 nm

Nanoparticles

- Li & Draine 2002, infrared signature of silicon nanoparticles in the ISM
- Presence of silicon nanoparticles in the solar corona postulated in Habbal et al. 2003 to explain tangential polarization and a slower fall off of intensity than the continuum



Nanoparticle fluorescence spectrum



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Conclusions

- Product: Two broadband spectra from two unique positions in the corona for comparison with similar eclipse data
- Dust model agrees with color observations in the outer corona
- Future plans:
 - Obtain more detailed results from F corona dust models
 - Repeat the experiment with a new spectrograph/fiber arrangement

References

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Mann, I., 1993, The Influence of Circumsolar Dust on the Whitelight Corona–Study of the Visual F-Corona Brightness, Planet. Space Sci., 41, 301-305.



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Additional Figures

Instrument Response

Instrument calibration of spectral response using a 3100 k halogen blackbody



Line Doubles

- Bright lines have shifted components in prominence regions
 - Implied velocity shift of ~3000 km/s
- Experimentation will show the truth!



Argon line source and selector slit



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Results

- Reduced, response corrected time sequence of spectra
- Flattened time sequence of spectra
- Emission line IDs from position I for spectra originating in prominences and quiet coronal regions

- Median spectra from position I and position 2
- Relative color of position
 2



Position I median quiet spectra



Position I median prominence spectra



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Position 2 median spectra



Solar disk spectra



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Daytime sky spectra





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