Determination of the solar chromosphere depth in May 2003.

Jean Bourgeois

Two good opportunities for measuring the solar chromosphere depth (or thickness) occurred in May 2003. The Mercury transit on May 7 and the annular solar eclipse on May 31 allowed observers to time starts and ends of these events in two different wavelengths: in green light, corresponding to the photosphere, and in Hα, corresponding to the chromosphere. The difference between these two timings would give an estimate of the chromosphere thickness at the concerned solar latitudes. In this paper, we don't take account of the chromospheric spikes, and we consider only the chromospheric layer, which is actually the radius difference of the sun in these two wavelengths.

This kind of observation is seldom achieved. The literature mentions only two observations, one from Russ Sampson in 1994 (*Sky & Telescope, November 1994*) and another one from the author in 1996 (*IOTA/ES, 1997 symposium*). A call for a collaboration was dispatched by the author in April 2003 through IOTA and other associations of solar observers. Results came in from many parts of the world like Brazil, Australia, Germany, France and Belgium. Unfortunately almost all the efforts to time the events in Hα failed, due to clouds or technical problems. The exceptionally good conditions met in Belgium nevertheless allowed the SIDC, at Uccle Observatory, to record the Mercury transit in the ionised hydrogen wavelength with a 1024 x 1024 pixel still camera, while the author recorded the events in video in Hα and simultaneously observed visually through a green filter. It appears that the images from the SIDC, taken with too small a scale (the pictures show all the solar disc), are not easily analysed. On another hand, the visual observations received from other observers, despite of their good quality, couldn't be fit together, having been made with different filters or without any filters, except those currently used to attenuate the solar brightness. These filters have various frequency responses, and the observations were therefore not consistent enough. Here is an account of the results obtained from the author's observations.

The Mercury transit

From Belgium, this event started low in the North-East, at only 9° above the horizon. The weather forecast was not favourable at the author's station for the sunrise hours, and he decided to move nightly toward Flandern to observe the first contacts with a better chance of success. The equatorial mounts were perfectly adjusted before the sunrise, and the observation was correctly done, without any technical problems, despite of a rather strong atmospheric turbulence.

A 80 mm F/D=15 refractor, whose aperture was reduced to 40 mm, was used with a Lumicon 0.14 nm Ha filter and a Philips NXA1001/3 video camera. The recorder was a SONY betamax. The event was observed visually through a 135 mm F/D = 6 reflector equipped with a green filter centred on 550 nm with a 100 nm half transmission bandwith, at a power of 80x. The time reference was given by DCF77 synchronizing a date and time video generator.

The end of the event was observed from the Reux Astronomical Station, where the weather became more favourable, with the same instruments. The differences between the timings in these two wavelengths were large, due to the slow motion of the planet, as high as 37 sec and 28.5 sec for the internal contacts. The external contacts were too hard to observe accurately to have been used for the reduction.

Jean Meeus kindly created a programme to reduce the observations. Here are the results :

First internal contact	chromosphere depth:	**1223 km**	heliographic latitude:	**82°N**
Second internal contact		**884 km**		**02°S**

The uncertainty is estimated at 100 km.

The annular eclipse

Once again the weather was favourable in Belgium. Only the last contact could be observed from that place, at an altitude of only 6°, early in the morning. No other observations were received from abroad. This time, the technique was improved, the visible wavelength observation recorded in video through a green interference filter centred on 546.1 nm with a bandwith of 3.81 nm, using a 100 mm F/D=10 Maksutov reflector and a Sony High 8 camescope. The filter was kindly loaned by the Institute of Spatial Aeronomy, based in Uccle.

The lunar relative movement was much faster than that of Mercury, of course, and the timings difference was only 1.20 second. Using the chord method to accurately time the last contact in the two wavelengths, another programme written by Jean Meeus gave this result :

Chromosphere depth: **1503** km heliographic latitude: **38°N**
The uncertainty is estimated at 100 km.

Conclusion

The partial eclipse of 1994, observed by Russ Sampson and carefully reduced with the Jean Meeus method, showed a chromosphere depth of 1432 km at a heliographic latitude 25°S. The author's observation on 12 October 1996 gave 1545 km at 20°N. The 2003 values are more or less consistent with the previous ones. The latter result, from the solar eclipse fits very well, while the transit's results are somewhat low. We don't know how is varying the chromosphere depth with time and solar activity. Many more observations are needed. The author invites solar and occultation observers to participate on the next events.

I wish to thank Jean Meeus for his precious collaboration in the computation, David Bolsee (IASB) who helped with the loan and calibration of the green filter, and all the observers who have sent their observations. It's a pity the author couldn't use these nice observations in this article. Hopefully the next transit of Venus and the next solar eclipses would be the opportunity to collaborate more productively with all these nice persons, with a special effort in the Hα wavelength, and a better selection of filters in the visible light.

Jean Bourgeois
Ruvonia Astronomical Station
B-5570 Honnay, Belgium
bourgeois.jean@skynet.be