IMAGING THE GREAT AMERICAN ECLIPSE IN CALCIUM-K

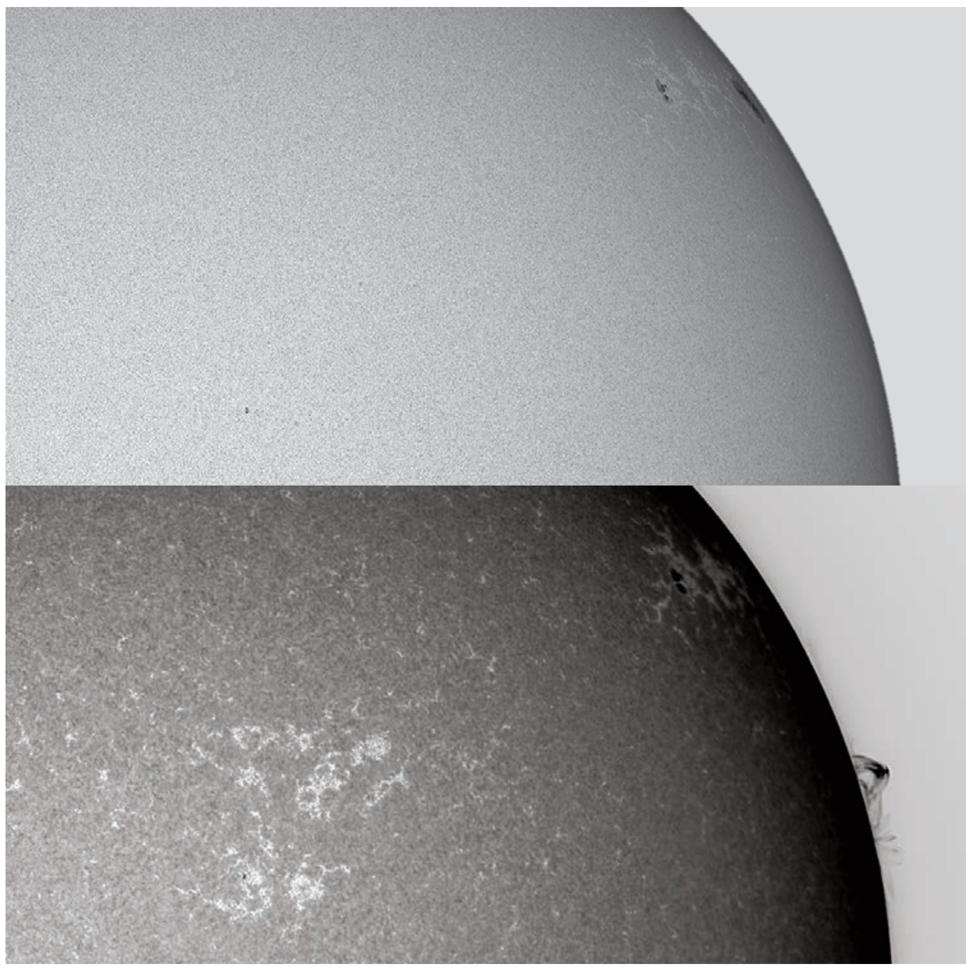
Exploring the C-K Option

By Jim Thompson

Even now, many months later, I can still feel the excitement of this summer's total solar eclipse. The grandeur of the experience was not lost on me or my family, and I have no regrets over hauling them along on a road trip across the U.S. to be in the path of totality. Behind all the excitement of seeing the eclipse was a lot of careful planning, including planning of how I intended to capture imagery from the event. As indicated by the title of this article, my plan was to image the total solar eclipse using only Calcium-K.

I did not come to this decision easily. I did a lot of research on websites and user groups, even reading through dozens of scientific papers. The consensus appears to be that the best option for imaging solar eclipses is to use white light. Before totality, most photographers use a white-light solar filter to safely capture images of partial phases, then remove the filter during totality in order to capture the chromosphere and much dimmer corona.

My problem with the consensus was that the Sun is rather boring in white light, especially considering we are in a period of low solar activity. In my experience, CaK images provide a lot more detail (**see Figure 1**), showing not only sunspots and granulation



Figures 1a and 1b - Comparison between Sun imaged in white light (a) and CaK (b).

Figure 2 - Image of ASI290 camera and manual 135mm Tamron lens used in imaging setup.

like you would see in white light, but also active regions called plages, mega-granulation, and in some cases prominences. The solar corona is also supposed to have a large white-light component, which in theory stretches down into the UV part of the spectrum, so it should be visible in CaK, as well. Imaging the eclipse in CaK seemed to me like a good way to go.

From my online research, it appeared, however, that I was alone in my opinion. I could not find any evidence of eclipse imaging being done in CaK before, and everyone I asked told me it was a waste of time. Challenge accepted!

One of the main problems people had with my idea was the large range of exposure times that I would need to deal with. The corona has roughly one millionth the brightness of the photosphere. The common way of dealing with this large range of brightness is to have an easily removable blocking filter that is used during the partial stages of the eclipse. How can such a large range of brightness be dealt with using a CaK filter, which itself blocks a very large amount of light? My solution was to use the combination of a camera lens with large aperture setting range and a CMOS-based planetary imaging camera with high sensitivity and low noise.

The lens is an old 135-mm manual lens made by Tamron, which has aperture settings from f/2.8 to f/22 (**Figure 2**). This I connected through a series of adapters to a ZWO-brand ASI290 monochrome camera. My CaK filter is a 1.25-inch thread-on

Figure 3 - Eclipse day image of lens, camera, and filters on Cube Pro mount.

Figure 4 - 850ms exposure of the Moon in CaK captured with final setup.

style purchased from Omega Optical in Vermont, USA. The whole assembly was mounted to an iOptron Cube Pro to allow for tracking during the event (**see Figure 3**). The setup was very compact and light weight, which was important since our trip involved taking commercial flights as well as camping our way along in a small RV, so I needed to keep my gear case small.

My plan was to image the partial stages with the lens aperture fully stopped down to f/22, and the camera exposure time down around

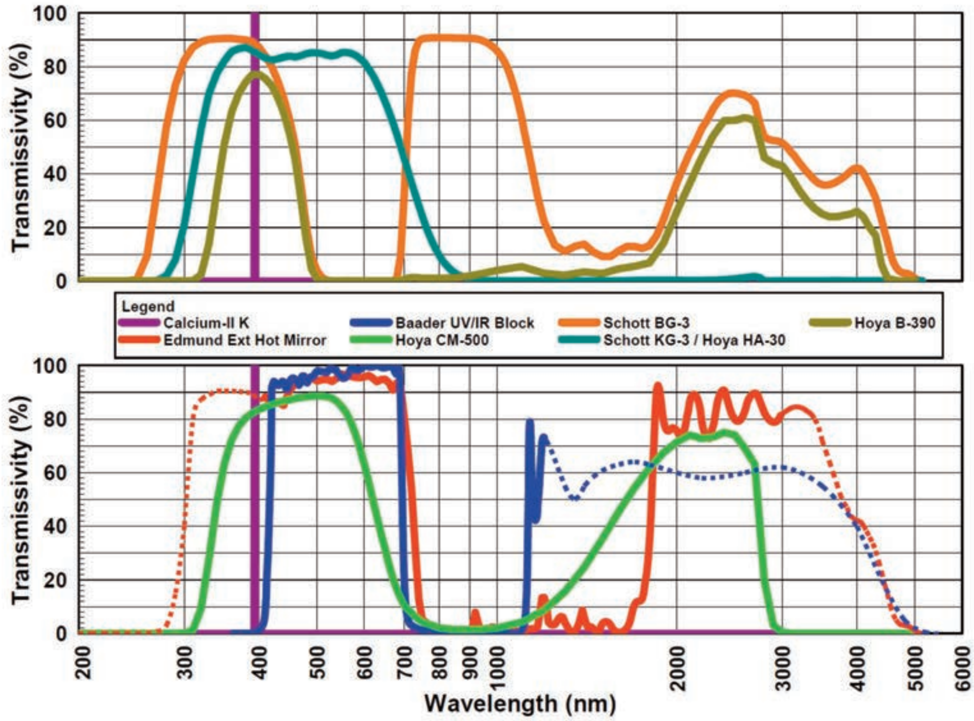


Figure 5: Response curves for the filters used in solar heating tests.

filter config	distance from focus		
	0cm (at focus)	2cm ahead	4cm ahead (filter loc.)
none	360-390 °C	201 °C	127 °C
Colour Correction (CM500)	183 °C	100 °C	70 °C
Baader Planetarium UV/IR Cut	264 °C	123 °C	75 °C
Edmund Optics Extended Hot Mirror	217 °C	130 °C	88 °C
Schott BG-3 blue coloured glass	155 °C	67 °C	47 °C
Hoya B390 blue coloured glass	77 °C	47 °C	41 °C
Schott KG-3 heat absorbing glass	220 °C	112 °C	71 °C

Figure 6 - Solar heating test results.

its minimum of tenths of a millisecond. During totality, I would open the lens aperture to f/4 and adjust the camera exposure into the 1- to 10-second range to get the desired view of the corona and other features.

I tested this idea out using the Sun and Moon in order to simulate the range of brightness I would be dealing with on eclipse day (**Figure 4**). These preliminary tests were useful, as they helped me determine that I could get a much sharper image using the lens at f/4 as oppose to its fully open position of f/2. So far, it looked like my idea was going to work. I had only to deal with one remaining concern: frying my camera.

In my early tests, I had only the CaK filter acting as a blocking filter, with the result being camera exposure times in the range I wanted. This left me a little un-easy as in the event the CaK filter broke due to it overheating, my camera would be toast – literally! I needed to find something to put over the front of the lens that blocked infrared but allowed CaK to pass unattenuated.

My first thought was to try the IR-cut filters I already had. I set up a very basic experiment where I measured the temperature at different distances behind the lens while aiming it at the Sun, placing different filters over the front of the lens to measure the impact. My initial tests showed that standard IR-cut filters fell short of what I wanted, so I ordered some other more specialized heat-blocking filters to try.

Looking at filter response curves, I also ordered a couple of deep-blue color filters to see how they performed (**Figure 5**). Through my testing, I discovered that it was not enough to block just IR, I also needed to block a big part of the visible spectrum, as well. In the end, the best performer by far was B390 color filter glass from Hoya (**Figure 6**). This finding was especially sweet since Hoya U.S. had sent me the samples of their filter glass for free.

With all the components in place, all that remained was for eclipse day to arrive. My family and I had a fantastic tour of the American Southwest leading up to August 21st. On the big day, all my hard work paid off, as my setup worked flawlessly. It was such a joy to just have the scope and camera chug away autonomously recording 100-frame videos every minute in the time leading up to second contact. At

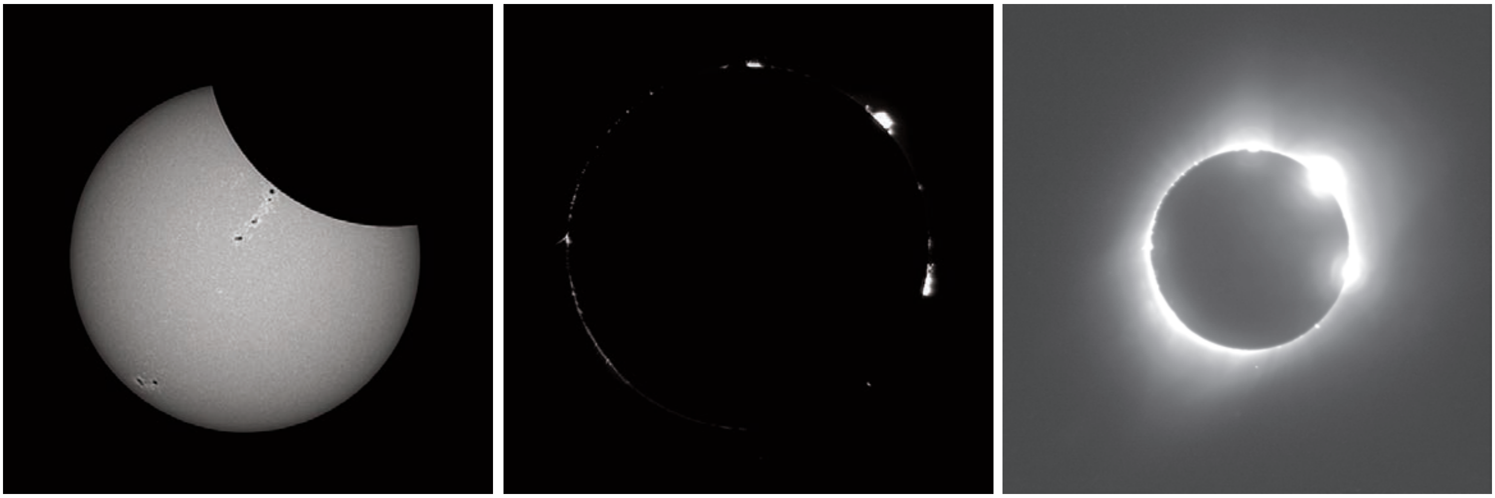


Figure 7: Images of the Sun captured in CaK during the Great American Eclipse.

that point, I quickly opened the lens aperture, adjusted the camera exposure time, and set to recording frames continuously for the duration of totality.

If I get another opportunity to use this setup during an eclipse, I will probably look into automating the change in camera settings, since it did take some of my time away from enjoying totality. At the end of the day, I think my attempt at imaging a total solar eclipse with CaK was a success (**Figure 7**). Perhaps my small success will inspire others to put their minds to something they enjoy and prove out their ideas even when people say it can't be done. ATT