asymmetry was apparent as soon as the binary becomes visible on Day 15, so the accretion stream has already formed by this time.

2. Days 26-41; Rim-Bright Disk w/ Radius 3.4 Rsun

Around Day 26, the shape of the primary eclipse changes. A simple analysis proves that all of the optical light is now coming from near the orbital plane. All light sources with radial symmetry fail by a lot. Disk sources with the light either centrally bright or uniform in surface brightness all fail by a lot. The only model that fits well is a rim-bright disk of radius 3.4 Rsun.
So the nova wind has turned dim. Also, this shows the appearance of the proto-disk. [Actually, the first of the normal flickering associated with the accretion disk occurs on Day 24.5] The bright rim is caused by some combination of the raised rims scattering more light and the lack of material in the inner part of the disk (because viscocity has not yet had a chance to fill up this region). The lack of a small-bright-inner light source explains why the raised rims of the proto-disk have nothing to eclipse to create optical dips.

3. Days 41-67; Center-Bright Disk w/ Radius 2.2 Rsun (quiescence)

The shape of the primary eclipse again changes. The eclipse mapping shows a source concentrated near the orbital plane, best fit by a centrally-bright disk of radius 2.2 Rsun. (Some egresses show 'wings' on the eclipses so that there must be some extra light outside this radius towards the position of the accretion stream.) This configuration is indentical to the quiescent configuration, so the disk has largely settled down.

4. X-ray Eclipse Mapping

The Swift satellite has a huge amount of data in the X-ray, with coverage throughout the entire eruption often at the every-orbit level. The SSS flux remains roughly constant (with a bit of a rise) from Days 14-33 (the duration of the optical light curve plateau), as predicted. This provides an excellent stability for eclipse mapping of the SSS.
For Days 15-21, I see peristent but 'fuzzy' evidence in the folded light curve for primary eclipses with total duration of ~0.3 in phase and 25% in depth. The duration points to a fairly large source, while the depth points to plenty of flux coming from above the orbital plane. A reasonable fit is obtained from a uniform spherical source that fills the space inside the companion's orbit. This is similar to the case of the optical eclipse mapping. I interpret the X-ray source as being largely X-rays from the central SSS being Thompson scattered off the wind.
For Days 21-28, the X-rays become much more jittery, with some

think that we are seeing a combination of effects as the optical depth through the wind varies, the raised rims of the proto-disk cause classic X-ray dips, and perhaps the hot spot contributes also with eclipses.
For Days 28-33, the X-ray eclipses are unambiguously visible, all with apparent depths of 25% and full durations of 0.2 in phase. The low amplitude, even for a time when the companion star completely covers up the WD and the inner part of the accretion disk, points to an extended source of X-rays, or at least to a small source (the SSS) where a large fraction of the X-rays are scattered from a much larger region.
After Day 34, the SSS is largely turning off fast, and I see no real pattern in the folded light curves. That is, Swift sees U Sco to vary substantially with no obvious eclipses.

C. ECLIPSE TIMES

1. Offsets During Eruption (and why they change)

We have 12 good eclipse times from during the eruption and one from afterwards. The orbital phase of these is evaluated with my ephemeris from quiescence as based on 45 eclipse times from 2001-2009. The O-C of these eclipses differ significantly from zero. The offsets from zero are roughly linearly changing in time. For Days 15-20 the offset is -0.013 days or so, with this negative value meaning that the
1th

2. Period Change Across the *1999* Eruption

I have observed 16 eclipse times from 1989-1998, 45 eclipse times from 2001-2009, and one eclipse time in 2010 after the eruption is over. I also have observed one eclipse time from the 1945 eruption (from the eruption I discovered in the Harvard plates), three eclipse times from the 1999 eruption (from the literature), and 12 eclipse times from the 2010 eruption (observed by many of us). This is 78 eclipse times in all.
I fit the 45 eclipses from 2001-2009 to a simple linear ephemeris to get HJD(minimum)=2451234.5387 + N*1.23054695. This should be used as the fiducial definition of phase. The RMS scatter of the individual observed times about this (or any other) best fit is 3.9 minutes, which is greatly larger than most of the measurement errors in timing. The cause of this is ordinary flickering during the ingress and egress that 'tilt' the light curve and slightly bias the minima times. So the way to get better periods is to measure many eclipses so as to beat down the random intrinsic timing jitter. From the 2001-2009 interval, I can also fit for a parabolic term in the O-C diagram (i.e., a steady Pdot term, such as expected from conservative mass transfer). I find that Pdot must be rather small, with the best fit value negative, and it being consistent with zero to within two sigma. A negative Pdot works in the opposite direction of conservative mass transfer, which implies that the quiescent U Sco must have some angular momentum loss mechanism (e.g., due to magnetic fields and winds).
I have only recently realized that a substantial problem is that the steady period change (Pdot) is degenerate with the sudden period change across eruptions (DeltaP). That is, for the one-sigma smallest negative Pdot, the best fit O-C curve from 1987-2009 has a negative DeltaP, whereas for the one-sigma largest negative Pdot, the best fit has a positive DeltaP. (I find the same result for the 84 eclipse times that I have from 1926 to 2009 for the recurrent nova CI Aql, with the derived DeltaP across its 2000 eruption similarly has a best fit DeltaP being negative, even though DeltaP=0 is within the one-sigma range.) This degeneracy has substantially increased the error bars for my measures of DeltaP. The prospect of a negative DeltaP is daunting, because the nova mass ejection contributes a positive DeltaP, while dynamical 'friction' in the common envelope phase is certainly too small to work. So Martin et al. (2010, arXiv:1003.4207) have proposed a mechanism involving the magnetic field of the companion star operating on the ejected mass to carry away angular momentum.
Neverthless, for U Sco, I derive DeltaP = (+43 +- 69)x10^-7 days, and hence Mejecta=(43+-67)x10^-7 Msun. (For CI Aql, I derive Mejecta<1x10^-6 Msun.) This result will improve substantially soon as the post-eruption constraints on Pdot are improved greatly in the next few months. And in a few years, I will have a measure of the DeltaP across the 2010 eruption.

D. LINE PROFILES

1. 'Batman' Profiles

For Days 0-5, the line profiles (eg. of the Halpha, Hbeta, PaschenGamma, BracketGamma....) appear triple peaked, with the two outer peaks being sharp topped at around +-5000 km/s, and the center peak being rounded and broad. With appropriate scaling, these look like the profile of Batman viewed face-on, where the two outer peaks are the ears of Batman and the central peak is the top of Batman's cowl. These were new to me, and so I had previously highlighted them as a mystery.

I have now reviewed all the spectra of U Sco and determine what is going on systematically. I find that all the lines (optical and IR, hydrogen and non-hydrogen) have the same profiles at any given time. The Batman profiles are seen prominently up until Day 5 or so. After that, the 'ears' go away, and we see only single sharply peaked lines with very broad wings. But then, on Days 16-23, the hydrogen lines all become triple peaked, with the peaks at +- 1800 km/s and all three peaks are well isolated. So with two episodes of triple-peaking, perhaps we have two mechanisms.

Jen Andrews and Chris Gerardy have pointed out precedents for 'Batman profiles'. It turns out that such profiles are seen in Type IIn supernova and in other novae. Dave Lynch has been calling the profiles the torus will pass just below the edge of the 'upper' mushroom cloud, and so we'll have a relatively clear line-of-sight.

2. 10,000 km/s

The expansion velocity of the U Sco is variously given as HWZI=5500 km/s (Arai et al. CBET 2152), HWHM=3800 km/s (Anupama et al. ATel 2411), and HWZI=5000 km/s (Ashok et al. CBET 2153), while later reports quote 3000-4000 km/s (Ness, ATel 2469). [This is expected as the 1999 eruption had the line widths decreasing linearly with time.]
However, D. P. K. Banerjee, in a private communication, has pointed out that the line profiles have consistent wings in early times that extend out to expansion velocities of 10,000 km/s. These wings are outside the 'Batman' profiles, are seen for Br-gamma, H-alpha, and N-I lines, and were visible in spectra from the 1999 eruption. Banerjee's discovery is quite astounding, as here we see a nova ejecting material at supernova velocities. Banerjee's discovery presents a strong challenge to theorists.

E. UNIVERSAL DECLINE LAW

1. Testing Prediction with Stromgren 'y'

Hachisu & Kato (2006, ApJSupp, 167, 59; and many followup papers) have presented a Universal Decline Law ('UDL') for nova light curves. In general, starting soon after the peak, the nova continuum flux will fall of as the -1.75 power of time (4.4 mag per log-time) and after a break time will have the flux decline as the -3.5 power of time (7.5 mag per log-time). The time of the break will depend primarily on the mass and composiiton of the WD. A complication is that the usual V-band magnitudes also include line flux, so there could be offsets from the UDL that predicts the *continuum* flux. They present the solution of looking at the light curve in the Stromgren 'y' band as this avoids most of the emission line flux.
For the purpose of testing the UDL prediction, Gerald Handler (at SAAO), Hiroyuki Maehara (at Kwasan Observatory), Seiichiro Kiyota (VSOLJ, Tsukuba Japan) James Clem (at CTIO), Arlo Landolt (at Lowell) all made series of magnitudes in Stromgren 'y'. The result is a near perfect

the light from U Sco after Day 15 is dominated by the SSS wind and after Day 41 by the accretion disk, so it seems that the UDL is irrelevant after the first 15 days. Third, the initial decline has various inflections (eg., due to the plateau), so an alternative fit is one with a break at 6 days, with the slopes (3.7 and 8.0 mag per log-time) being good for the UDL, with this fit ignoring all the data after the start plateau (with the pleateau light not being relevant for the UDL). These points need clarifiation, in particular as to whether the plateau light should be included in the fit.

2. Break Time and the Composition of the WD

The time of the break in the UDL depends on the WD mass and composition. Table 10 of the Hachisu & Kato paper give a list of the break times for WD masses from 0.6-1.30 Msun and for CO and Neon WDs. The U Sco WD is more like 1.37 Msun, so an extrapolation or further analysis are needed. With an extrapolation, the CO WDs might have a break at perhaps 10 days, while the Neon WDs might have a break at 15-20 days. This is to be compared to the fits which give break times of 24 days or 6 days depending on whether the plateau light is included or not. It seems that with a little theoretical guidance (break times for 1.37 Msun, whether to use the plateau), we can get a good answer to whether the U Sco WD is CO or Neon in composition.

F. LOOKING FORWARD

1. Mejecta From Spectral Energy Distribution

Shara et al. (2010, ApJLett, 712, L143) put forth a new idea that the total mass ejected is simply proportional to the total radiated energy. The constant of proportionality is established to be a constant and evaluated by their many nova models. So now we have a new way to measure Mejecta. And this way is independent from all other ways.
To get this new method working, we have to have full spectral energy distributions over a wide spectral range over the entire time of the eruption. And we also need a reliable distance so as to convert the observed flux into luminosity. Before this U Sco eruption, no nova comes close to being well enough observed, with few having even one day of UV or X-ray observations, much less far into the IR. (The 2006 eruption of RS Oph comes close, but this is still missing the IR and the full time coverage.) And almost all nova have factor-of-2 distance uncertainties, which result in 4X errors in luminosity and 4X errors in Mejecta. (The MMRD relations have a factor of two uncertainty, and other methods are only worse in accuracy. Only novae in globulars [T Sco] and in other galaxies have accurate distances, except...)
U Sco is the perfect nova to which to apply the new Shara method.
Only U Sco has daily X-ray plus UV plus UBVRIJHK plus midIR throughout the entire eruption. Only U Sco has an accurate distance (12+-2 kpc) because

rate as a function of time for the SSS wind?
So sometime in a few months, their global analysis should give unique and reliable results for many of the key questions on the physics of the nova ejecta.

Cheers,
Brad

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