Comments from Steve Shore (Universita da Pisa) (18/8)

At the start of the expansion, at least when we see the nova visibly, the ejecta should pass through a stage called the fireball. This is an opaque stage that resembles a single expanding surface, or a sort of thin atmosphere, with an almost uniform temperature. Usually that isn't observed but in this nova it might have been caught.

Au début de l'expansion, au moins quand nous percevons la nova visuellement (RP :à l'oeil nu ?) l'éjecta devrait passer par une phase dénommée "fireball" (boule de feu).
C'est une phase opaque qui ressemble à une simple surface en expansion, ou une sorte de fine atmosphère, avec une température presque uniforme (RP : une bulle...).
Normalement, ceci n'est pas observé mais dans le cas de cette nova nous pourrions l'avoir vu.

The expansion velocity is high enough that the matter can't radiate efficiently enough to cool by energy loss, the temperature drops instead because of the increasing volume at constant mass -- he energy density is dropping.

La vitesse d'expansion est assez haute pour que la matière ne puisse suffisamment rayonner efficacement pour se refroidir par perte d'énergie , en revanche le température baisse à cause de l'accroissement de volume à masse constante : la densité d'énergie chute.

This is the same as saying that the total energy remains almost constant but the temperature decreases. Then something important happens. When the matter gets cool enough, first the hydrogen and then heavier elements start to recombine.

C'est la même chose que dire que l'énergie totale reste à peu près constante mais que la température baisse. Alors quelque chose d'important se produit. Lorsque la matière devient assez froide, d'abord l'hydrogène et ensuite les éléments les plus lourds commencent à se recombiner.

This releases some energy (from the excess energy of the electrons as they're captured by the ions) but mainly that the neutral and low ionization stages have much higher line (and continuum) opacities and the absorption in the ultraviolet increases quickly.

Ceci dégage quelque énergie (l'excédant d'énergie des électrons lors de leur capture par des ions) mais principalement fait que les états neutres et faiblement ionisés ont une bien plus forte opacité de raies (et du continuum, RP : du spectre) et que l'absorption dans l'ultra_violet augmente vite.

The lines that absorb there are the ground state transitions; that is, they're the strong zero volt states. Their upper levels are those that both pump the absorption strength of the optical transitions and excite the levels to reradiate.

Les raies qui sont en absorption ici sont les transitions plancher ; donc, elles sont les forts états zéro volt. Leur niveaux les plus élevés sont ceux qui, aussi bien , pompent l'efficacité d'absorption des transitions optiques et excitent les niveaux à re-rayonner.

So the Fe II spectrum, for instance, suddenly starts to appear. There are coincidences with some of the He I lines, e.g. He I 5016 is close to Fe II 5018, the same for He I 4923 being near an Fe II line (in these cases they're both from the same lower level).

Ainsi le spectre du Fe II, par exemple, commence à apparaître. Il-y-a des coïncidences avec certaines des raies He I, ex : la raie He I 5016 (RP : Å) est proche de Fe II 5018, idem pour He I 4923 qui est proche d'une raie Fe II (dans ces cas, les deux sont du même niveau le plus bas).

The lack, in the last spectra, of He I 5875 gives the game away: the triplet series (He I 7065, 5875, 4471) being absent means the stuff at the near-coincidences if Fe II (and other heavy ions).

Le manque, dans le dernier spectre, de He I 5875 vend la mèche: le triplet (He I 7065, 5875, 4471) étant absent signifie que ce qui est en proche coïncidence est Fe II (et autres ions lourds).

In the Ondrejov spectra, we have Ca I 4226 yesterday suddenly making an entry. At the same time Ca II showed a higher velocity absorption than the H-beta line. So the ejecta seem to be showing some depth structure now.

Dans le spectre d' Ondrejov, hier, nous avons CaI 4226 apparaissant soudainement. Simultanement Ca II montrait une plus haute vitesse d'absorption que la raie H-beta. Donc maintenant l'éjecta semble laisser voir quelque structure plus profonde.

What all this means is that we're watching a stage in a classical nova that hasn't been covered since photographic series on DQ Her, the last nova that was bright enough for such coverage in the modern era, although DN Gem and CP Pup were also well covered (but not like what all of you have produced!)

Ce que tout cela signifie est que nous assistons à une phase d'une nova classique qui n'a pas été observée depuis la série photographique sur DQ Her, la dernière nova qui était assez brillante pour une telle observation dans l'ère moderne, bien que DN Gem et CP Pup aient aussi bien été observées (mais pas au point de ce que vous-tous avez produit !)

As I've already written, we're in new territory here -- between observational capabilities and opportunities to catch individual events -- so it's important that you keep up your courage and bang away. It is possible that within the next week there 'll be a shortlived absorption stage in CN 4216 (and also 3883).   In the IR there should be a CO 2 micron emission stage. If the nova isn't a DQ Her type, then we really have no analog.

Comme je l'ai déjà écrit, nous sommes sur un nouveau territoire à ce point – entre capacité d'observation et opportunités de saisir des événements spécifiques - donc c'est important de garder courage et de tenir le rythme. Il est possible que dans la semaine qui suit il-y-ait une phase d'absorption CN à 4216 (et aussi 3883) de courte durée. Dans l' IR il devrait y avoir une phase d'émission CO à 2 microns. Si la nova n'était pas de type DQ Her, alors nous n'aurions pas d'analogue (RP : connu, de type connu)

The continuing fluctuations in the photometry, also known from other novae at maximum light, remain a very deep problem and, again, any observations with the highest possible cadence (this also means longitude coverage from all of you to get the most continuous sequences) will be critical.

Les fluctuations continues de la photométrie, connues aussi d'autres novae au maximum de luminance, reste un sérieux problème et, à nouveau, les observations avec la plus haute cadence seront déterminantes (ceci signifie aussi les moyens de couverture en longitude de vous tous pour obtenir les sequences les plus continues possible) (RP : il-y-a un grand trou de couverture dans la zone Pacifique... Je me demande ce qu'il entend par haute cadence, pour moi c'est très stable au niveau 30 sec, quelques minutes, heures...)

For instance, the disappearance of the He I corresponded to a "local" peak in the optical light, this could be a recombination event or it could be multiple ejections. To speculate, so early, is too risky (even for a theorist!) so I'll stop now and hope this explains the stages you're seeing.

Par exemple, la disparition de He I correspondait à un pic "local" en lumière visible, ceci peut être un événement de recombinaison ou ce pourrait être de multiples éjections. Spéculer, aussi tôt, est trop risqué (même pour un théoricien !) donc j'arrête maintenant and souhaite que ceci explique la phase que vous observez.

One more point, though. The recession of the absorption velocity is something also known from the DQ Her outburst, this is an effect of the change in the transparency of the ejecta. If this is the effect of seeing deeper into the layers at first during the late fireball, then it should reverse as he recombination sets in and the ejecta cool.

Un point de plus cependant. La récession de la vitesse d'absorption est une chose aussi connue du sursaut de DQ Her, c'est un effet du changement de transparence de l'éjecta. Si c'est l'effet de voir plus profond à travers les couches du "fireball" finissant, alors elle devrait s'inverser lorsque la recombinaison s'établit et l'éjecta refroidit. _

Steve Shore

Comments from Steve Shore (15/8)

Francois asked that I bore you all with some explanation of what's happening in these data and perhaps to give you all some idea of what the physical picture is. It's a pleasure, also because it's a chance to say thank you to all of you for this amazing, invaluable effort. Once the smoke clears (well, after possible dust formation?), we'll have a chance to work through all of this for the eventual complete analyses. You're all involved with that.

First, this is a stage not often accessed in the optical, even less in the ultraviolet. In the first stage, after the explosion (that we don't see), the ejected outer layer of the white dwarf expand hypersonically and cool. Two things. First, this is a mixture of the stuff that was accreted on the WD during the pre-nova stage, when it sits inside an accretion disk from the companion and like a garbage disposal just accumulates the stuff. Once a sufficient pileup occurs, the compressed layer can initiate nuclear reactions and explode (well, this is the surface, not the center, so there's nothing to constrain the event). BUT there's a question even here. Theignition of the nuclear fuel is like a flame, in fact physically it's very close, and propagates like a flame through the envelope. This, in turn, provokes a buoyant mixing (to avoid the word "boiling" but it's a similar thing) that also dredges material from deeper layers. A major uncertainty, of almost cosmological importance, is how much of that mixed matter is blown off and whether the WD mass increases or decreases. But that's for another time.

For this stage, the explosion throws the gas off like a shell but with a catch, the velocity depends on radius because the range of velocities is ballistic and within an interval from the escape velocity to whatever can be reached by the energy of the explosion. So you will see velocities up to thousands of km/s. On this, a word of caution.

I'll always, in any of these notes, emphasize that what you see is NOT the whole story. The ejecta are not completely transparent at all wavelengths and you see to different depths of this fog -- just like a fog -- depending on whether you're in the lines, continuum, the optical or UV or IR -- in other words, a radiographic image of a human is similar. You see to the depth from which the light can escape to you, the surface -- the "photosphere" to those who want to be technical – is wavelength dependent.

The same with the velocities. You see different line profiles on, for instance, each Balmer line. Since the sequence from H-alpha to beta and so on. is also one of intrinsic opacity (strength) you see deeper in H-gamma than H-alpha and the line is formed mainly ("weighted toward") the inner ejecta. So the combined line profiles, viewed in velocity, are the probe – tomorgraphy -- of the ejecta. With this you can look for structure, dynamics, even variable abundances. The trick is following the seqeunces and seeing how each part of the spectrum develops. The Fe lines appear because the UV is opaque and the absorption at high energy excited the optical (low energy) lines. The same for the He and Balmer lines. In all cases, the classes (Fe, He/N) are not anything but descritpicve of this stage.

The spectra you all got last night were from the fireball, the initial tage of the expansion that is hard to catch. Now you'll see the next pass, as the ejecta start to recombine and turn into a dense "fog". Then, as they thin out (weeks from now, likely) the emission will appear again but in the first stage the lines pass from ionized and He and H to those of more easily ionzed heavy metals that would have been too ionized to observe in the fireball.

I hope tis helps. It's just the star, if there's anything anyone would like to see or if anyone has questions or comments, youknow I'm always online (shore@df.unipi.it) even at the risk of filling all of our mailboxes.

steve