



# The *Variable Star*

## OBSERVER

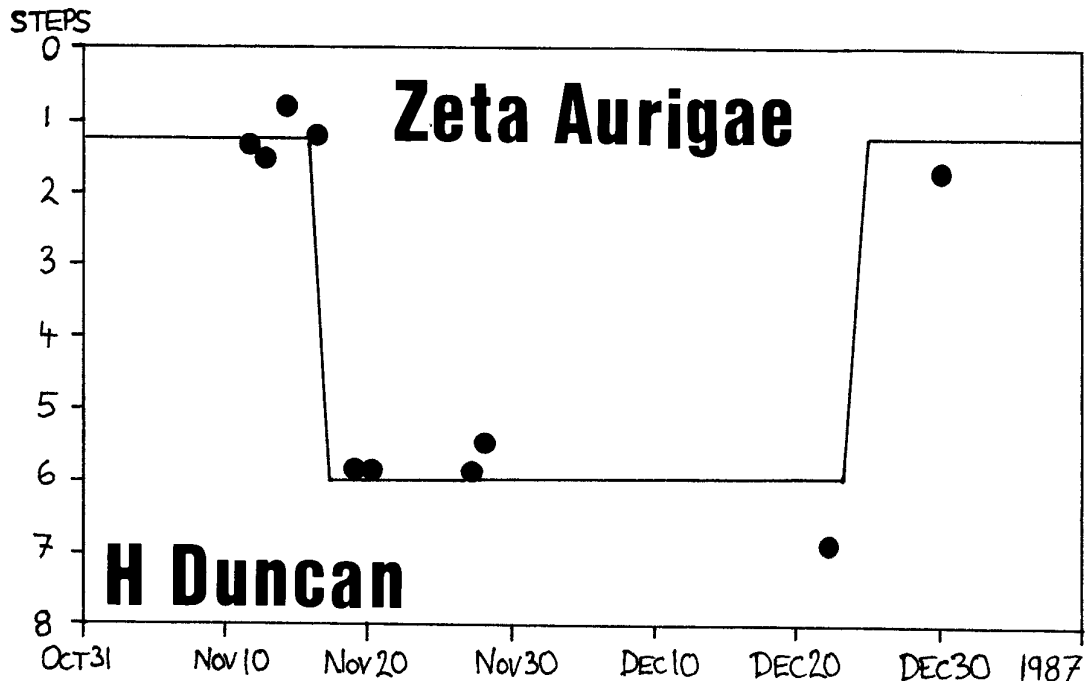
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### Observer Profile: Hugh Duncan

Hugh Duncan was born in Leicester in 1957, his father being a college lecturer and his mother a nurse. They moved to London and he has spent most of his life there. As a child, he was always interested in science and maths. He was introduced to astronomy in the same way that many other people have been - via Patrick Moore. It was Patrick's explanation of the solar eclipse of 1968, and Hugh's subsequent viewing of the event which got him hooked. In 1969 he joined the JAS and he remained a member until 1990.

From 1968 Hugh had determined on a career in astronomy and he eventually went on to take a degree in it at University College London. Peter Birtwhistle, of The Astronomer was in the same

year. Hugh graduated in 1980 (taking four years as he had flunked his first year). He says that his fondest memory of that time is of working for Dr Guest at the Mill Hill Observatory on the impact craters of Mars. The martian surface is a topic that comes a close second to his interest in variable stars. As careers in astronomy are hard to find, he settled for on in science, and became a physics teacher instead.

Although Hugh had spent many years observing, he had never done it in a serious way. Things come in cycles, and he chanced to see the (very) partial eclipse of the Sun in December 1983 and this got him thinking about stellar eclipses. In a few weeks he was outside making observations of Algol and Beta Lyrae and then all kinds of variables stars. He got in touch with John Isles, who encouraged him to make more observations, and Hugh was chuffed to find that, over the next couple of years, he had become the leading variable star observer in the JAS.

Hugh is basically a 'low-tech' person. This, he says, is due to a combination of impatience, poverty and lack of spare time. He likes to get results quickly and doesn't like standing around in the dark, freezing. Because of this, he has been, and still is, basically a naked-eye observer, watching all those bright, unfashionable variables on the JAS program. He resort to 7x30 or 10x50 binoculars for those awkward 'eclipsers' that fluctuate between mag 6 and mag 8. Besides eclipsing binaries, he also likes to follow Cepheids. As these can be observed daily, you can usually get enough observations over a year to form a decent light-curve.

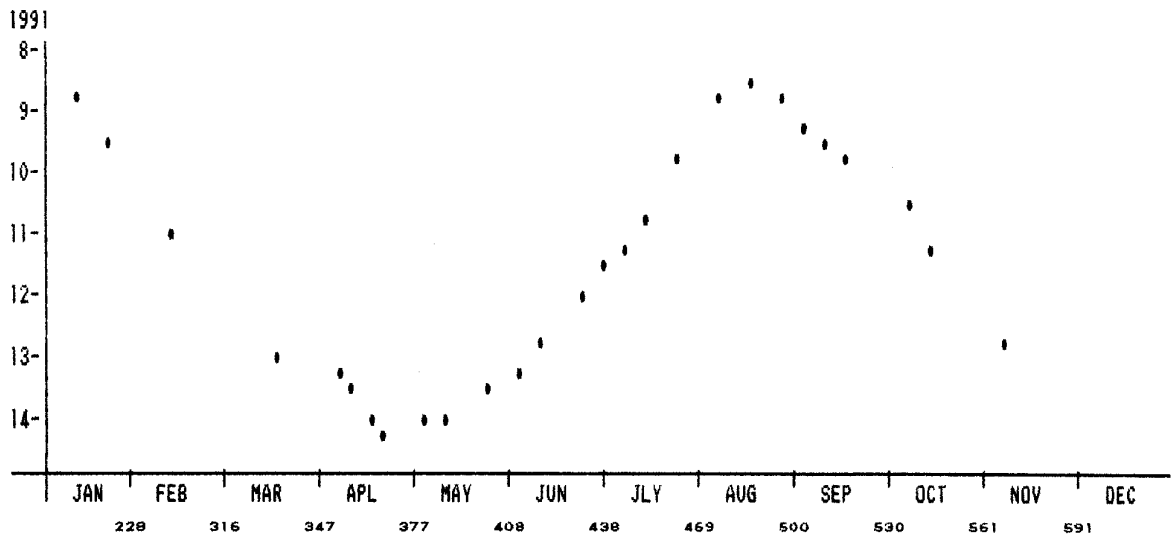
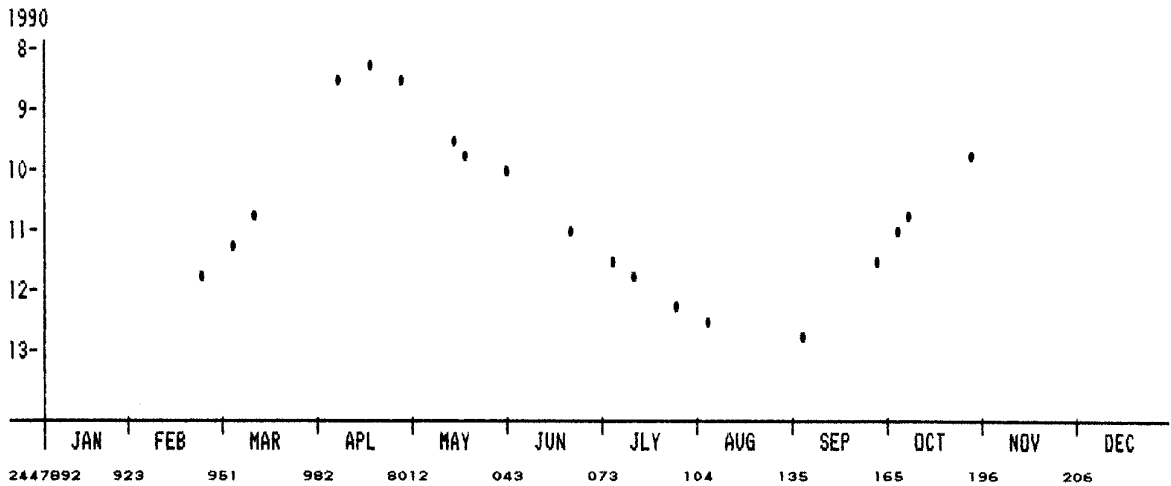
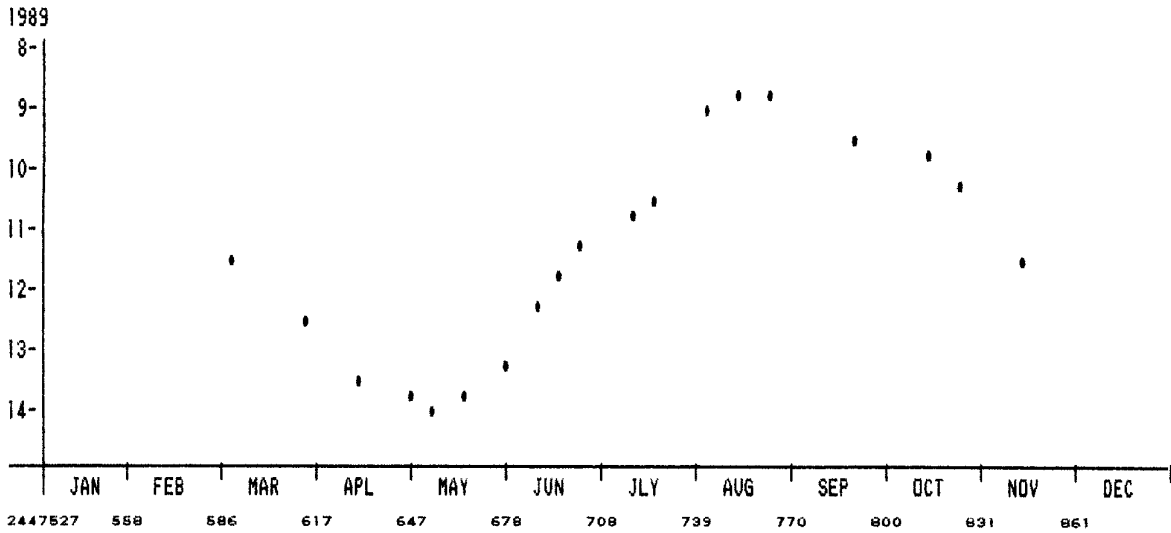
Hugh joined the Crayford Manor House Astronomical Society in 1985 and, in 1988, he lectured the CMHAS Beginners Astronomy class for that year. He says that he enjoyed working with Roger Pickard, John Howarth, and the other members, and took to observing a few stars from the BAA VSS program as a result of their influence. However, he was also keen to have clearer skies and, in 1989, he moved to the south of France where he now teaches physics in the American International School. This work, plus the fact that he is building his own house (!), does not leave him much time (or energy) to take advantage of the better skies. However, he does force himself outside to take a look, last thing at night, but he always feels that his observations have much room for improvement.

He says he finds it difficult to pick out a favorite light-curve but he sent the accompanying light-curve of Zeta Aurigae. This is based on photographs taken through a blue filter. The slides were then coded and shuffled before the light estimates were made from them. The graph shows that these 'unbiased' magnitudes closely match the predicted light-curve.

Hugh says that he has far too many other interests and admits that he is probably a 'Jack of All Trades' and therefore master of none. His photography interest overlaps several other of his interests besides astronomy. He avidly researches his family tree, writes songs and is helping to save the last remaining populations of Hermann's Tortoise in the south of France. He likes writing and would like to have more of his work published. So far, his only success has been an article in Astronomy Now.

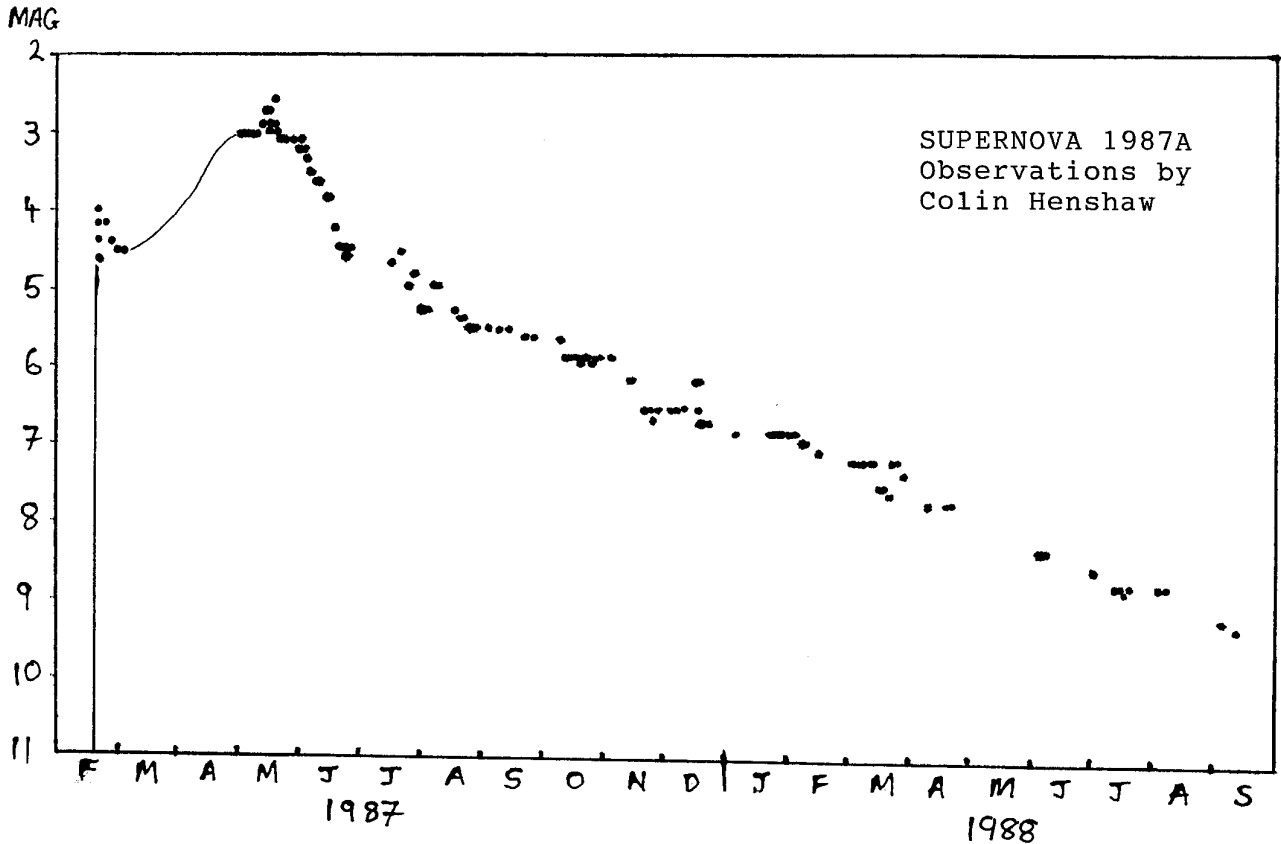
W Coronae Borealis

The following light-curve has been supplied by Gary Poyner. It is based on his observations with a 25cm and a 40cm reflector. W CrB is one of the fainter Mira stars on the VSS program. Maybe this light-curve will inspire more people to follow this star. The next maximum is due at the end of March or beginning of April.



## Supernova 1987a after Five Years

February 23rd was the fifth anniversary of the Supernova in the Large Magellanic Cloud. A comprehensive review of our current knowledge of this event and its aftermath recently appeared in Nature (R.A. Chevalier, Nature, 355, 691-696). This covers the nature of the progenitor star, the nature of the compact remnant, the properties of the ejecta and its interaction with its surroundings, and the relationship of SN 1987a to other supernovae. The VSO cannot compete with such a tour-de-force so, instead, we have included a copy of Colin Henshaw's light-curve which is based on his observations from southern Africa.



### A Letter from Russia (Passed on by John Isles and Melvyn Taylor)

Dear Friend,

Since 1981 I have been a member of the All-Union (ie: Soviet Union) Society for Astronomy and Geodesy and have performed observations of variable stars, occultations and other things, sending the results to the society's centres in Moscow and Odessa. In return I used to get some useful recommendations and charts. But as a result of the crisis in this country and disintegration of the (Soviet) Union, the society is not so active as it was before, nor is it easy to procure its Annual. Of course, it will be alright again later on, and I am not going to stop sending my results to Moscow and Odessa. But to be sure that they don't remain unprocessed I should also like to send them to some other organisation. I tried to contact the AAVSO but the letter came back to me, marked 'Forwarding Order Expired'.

So I would like to know what kinds of observations are processed by the BAA and in what form the results should be sent. Such data as mean seasonal maxima and minima of periodic stars, moments of Universal Time and Julian Dates, and differences between observed and

predicted maxima and minima I can find myself. I have an 80-mm refractor and 50-mm binoculars at my disposal. I should be very grateful if you would let me know more about the activity of the BAA and how I can contribute to it. I should also like to have a pen-friend from among my British amateur colleagues. My address is: D. Kazansky, Menshikovskiy Pr., 15/2 - 15, 195273 Saint Petersburg, RUSSIA. I am an undergraduate student in the Oriental Department of St Petersburg University.

Faithfully yours, Dmitry B. Kazansky.

### Corrections

**Roger Pickard** writes concerning the report on John Howarth's talk in VSO 8: "Although Crayford Manor House Astronomical Society is indeed looking after the Hewitt Camera Archive, and we did receive it from the RGO, we are only doing so on behalf of the BAA who are the official custodians. Also, it was reported that much of the computerised data was entered by the wives of Crayford members, whereas in reality it was the members themselves who did it, although it happens that two of them are ladies (but not wives of members!)."

### Observing Variable Stars in a Flood By Antonín Dědoch

Originally published in 'Perseus', the circular of the Czechoslovak Variable Star Observers (No 3, page 15, 1991). Translated from the Czech by Jindřich Šilhán. Antonín Dědoch is one of the leading variable star observers in Czechoslovakia.

At the beginning of August 1991, the republic of Czechoslovakia suffered some quite severe floods. They were especially bad in the Šumava Mountains where several bridges were washed away and a number of holiday chalets had to be evacuated. Now, I actually rent a cottage in one of the worst-hit areas and there I keep my telescopes and astronomical books and charts. On hearing of the flooding, I decided to visit my cottage at the first opportunity in order to see what damage it had sustained.

So, I took a couple of days holiday from my work in Prague and set off for the Šumava. I arrived there only two or three days after the height of the floods which had been accompanied by the breaching of a dam on a nearby lake. The water level had dropped quite a lot by the time I got there, so I didn't have any difficulty getting to within sight of my cottage. The water had washed away most of the garden fence so I didn't even have to go the long way round by the gate, but could take the most direct route to the door. However, there were other obstacles in the last few metres of my journey: I had to cross a torrential stream and to avoid a noisy dog which seemed to be trying to make up for the missing fence. When I got there, I found the garden to be in a sorry state and the cottage was partially damaged, but my two telescopes and my books were unscathed.

I spent all of the afternoon hard at work repairing the flood damage. By the evening I was pretty tired and was ready for a well-earned rest when some of the neighbours called round to tell me that the sky had cleared and asking if I would be up observing through the night. Now, this question was not motivated by any

interest they had in variable stars but because they needed someone to stay up all through the night to keep an eye on the water level and to warn them if it started to rise again. If I was to be out observing then they could all go to sleep.

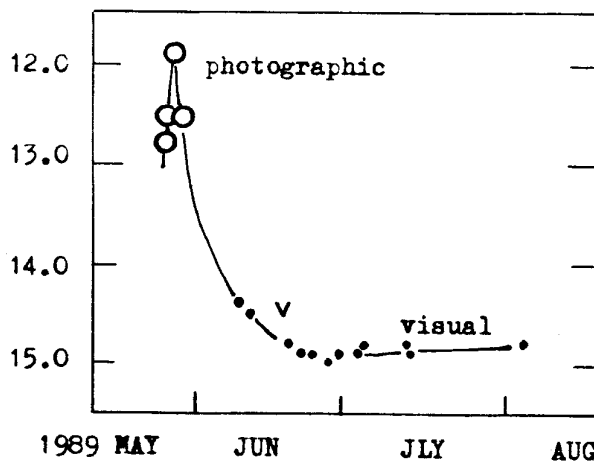
Needless to say, I didn't need to be asked twice! I got out my smaller telescope and set it up on the only piece of dry land, which was still only half a metre above the level of the raging torrent. I had no choice as to which stars I was going to observe because I had not brought any predictions with me. So I observed stars with unknown light elements, for which no predictions would have been available anyhow. The actual making of the observations was a bit more problematical as the patch of dry land on which I was trying to observe had been turned into a vast storage area. There were rabbit hutches (with rabbits), sacks of corn and many other things, some of which I had no idea of what they were. After a bit of a struggle, I set up the telescope in among all these things and cleared a little space for myself. The sky conditions turned out to be extraordinarily good because the flooding had cut off the electricity supply to the whole area. The situation I found myself in was a bit surreal: It was pitch-dark, there was turbulent, fast-flowing water to my left, calm, deep water to my right, the drenched cottage in front of me, and an impenetrable thicket resembling a tropical rain-forest behind me. And there was I, in the middle, with my telescope aimed at the starry sky.

Now and then, I even had visitors. The first was one of the neighbours who went by looking for some stray hens. A couple of hours later some other people came by looking for the stray neighbour. Then the watch-dog woke up, and it obviously thought that I must be up to no good. However, in spite of its vociferous protestations, I managed to complete all of my observations.

And, after having been through all this, I can authoritatively state to other observers that it is possible to make variable star observations in the middle of a flood. And if you are lucky and the local power station has been washed away then it can be downright excellent!

A Black Hole in the V404 Cygni System  
By Tristram Brelstaff

The search for black holes within our Galaxy has been going on for over twenty years now and is just beginning to reveal convincing results. The first good candidate found was the X-ray source Cygnus X-1 but, unfortunately, in this system the large mass of the blue supergiant component makes it difficult to determine the mass of the unseen component. All that can be said with certainty about the unseen component is that it must have a mass greater than  $0.25M_{\odot}$  (0.25 Solar masses), which is much smaller than  $3M_{\odot}$ , the upper limit for neutron stars. So it is still possible for Cygnus X-1 to contain a neutron star rather than a black hole. A more promising candidate came to light in 1975 when the recurrent X-ray nova now known as V616 Monocerotis suffered an outburst. The visible component in this system turned out to be a K5 main-sequence star of low mass making it much easier to put an accurate lower limit on the mass of the unseen component. However, the best lower limit was only  $2.9M_{\odot}$ , which still allows the object to be a neutron star (A article in the March 1992 Issue of 'Astronomy' indicates that this limit has recently been pushed up to  $3.8M_{\odot}$  which makes V616 Mon a more convincing case for a black hole).



## V404 Cygni

Photographic data  
by Mobberley.

others by Poyner

As with the 1975 outburst of V616 Mon, the 1989 outburst of V404 Cygni was first noticed in X-rays and only later identified with an optical recurrent nova. The previous outburst of V404 Cyg had been recorded as Nova Cygni 1938 when it had reached about 11.5 mpg. The accompanying light-curve of the 1989 outburst is based on data published in *The Astronomer* and has been supplied by Melvyn Taylor. During the 1989 outburst, various periodicities in the optical light-curve were reported but none of these could be unambiguously identified with an orbital motion, which could give information on the masses of the components. In outburst, the light from the excited accretion disk tends to dominate the light of the system and obscures the fine details in the spectrum which also might reveal orbital motion. This is why it wasn't until the summer of 1991, two years after the outburst, that J. Casares, P.A. Charles and T. Naylor (*Nature*, **355**, 614-617, 1992) used the William Herschel Telescope to scrutinise the spectrum of V404 Cyg for sign of orbital motion. They found that at minimum the system shows the spectrum of a late G or early K-type star. They also found that this star shows variations in radial velocity which can be explained as orbital motion with a 6.47-day period. The amplitude of the radial velocity curve is 21 km/s which is unusually large for such a long period. This allows an absolute lower limit of  $6.26 \pm 0.31 M_{\odot}$  to be placed on the mass of the unseen component. This is twice the mass of the largest possible neutron stars and so must be a black hole. Reasonable assumptions for the mass of the visible component and for the inclination of the orbit imply that the true mass is between 8 and  $15.5 M_{\odot}$ .

Casares *et al* consider, and discount, the possibility that the unseen component might be one of the recently suggested 'Q-stars' or 'heavy neutron stars'. Firstly, there is no independent observational evidence that these Q-stars actually exist and, secondly, V404 Cyg shows none of the X-ray pulses or bursts that are characteristic of neutron stars. They go on to consider the source of the material in the accretion disk around the black hole. For the G/K star to be the source it would have to fill its Roche lobe and, hence, it would have to be a giant star. However, taken with the faintness of the system at minimum, this would imply a distance of over 11 kpc which is unacceptably high. The preferred model has the G/K star as a main-sequence star sitting well within its Roche lobe, the accretion disk being fed by a red dwarf star orbiting much closer in to the black hole in a period of only 6 hours. This red dwarf must have a mass of less than  $0.5 M_{\odot}$  for it not to show up in the spectrum. There is some evidence for the 6-hour period in modulation of the H-alpha line (presumably originating in the disk? - TB) and in the optical light-curves obtained in 1989. However, no matter how the fine details turn out, the conclusion that V404 Cygni contains a black hole seems inescapable. As Casares *et al* put it: "We consider this the most persuasive case yet for the existence of a black hole".

Variables Near and Far  
By Tony Markham

It is difficult to determine the distance to a star. Other than for nearby stars, methods frequently assume that all stars of a particular spectral type and class are of the same intrinsic brightness and that their differing apparent magnitudes are due to the stars being at different distances. Obviously it is not easy to apply such methods to variable stars ! Consequently star catalogues often leave the distance column blank for variable stars. Sometimes however distances are given. The values given below are taken from Sky Catalogue 2000, the Atlas Coeli Catalogue and Burnham's Celestial Handbook and show the extent to which different sources may agree or disagree.

Comparison is made difficult by Burnhams quoting light years, Sky Catalogue 2000 quoting parsecs and Coeli quoting absolute parallaxes (usually to 3 dp). In addition, Sky Catalogue 2000 sometimes only gives lower limits to the distances. For simplification, all distances given below have been converted to light years (note that for the Coeli data this leads to very approximate values for distant objects).

Variable	Sky Cat	Coeli	Burnhams
R CrB	over 90	84	82 or 270 or several thousand
Algol	95	81	79-101
Beta Peg	180	170	210
Chi Cyg	82	230	300-400
Eta Gem	190	250	200
Alpha Her	over 220	540	430
Betelgeux	310	470	520
AR Aur	500	470	
VW Dra	500	650	
Mira	over 95	820	220
R Sct	2500	1600	2500-3000
Rho Cas	5000	820	200 or 3000
P Cyg	over 140	4700	3000
TV Gem	7000		
BU Gem	10000	4700	
W Cep	20000		

- the large differences in the quoted distances for R CrB and Rho Cas arise due to assumptions as to whether the variables involved are dwarf stars or supergiants.