The 2006 Outburst of the Recurrent Nova RS Ophiuchi

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Introduction – RS Oph

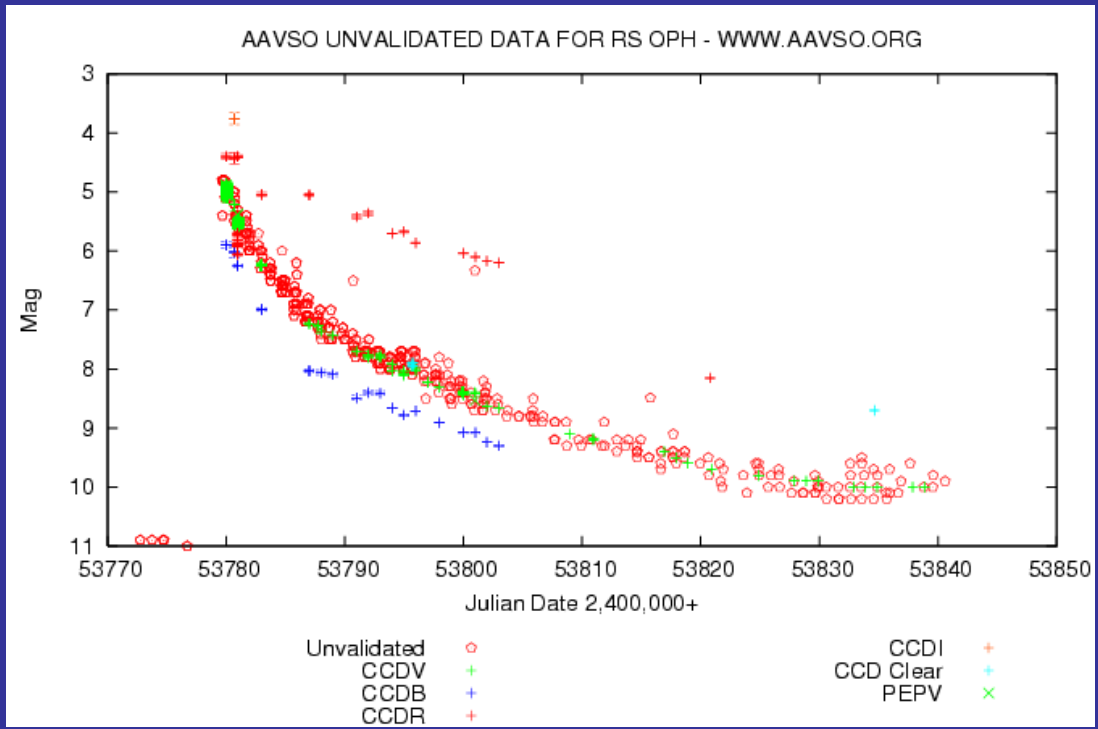
- Interacting binary system with an accreting white dwarf primary and an M2-3 giant secondary with an orbital period of ~460 days
- Recurrent nova that has suffered five recorded outbursts in 1898, 1936, 1958, 1967, 1985
- Fast nova, t_3= 8-10 days
- Optical spectrum during outbursts characterized by strong coronal and other high excitation lines that reach a peak around 60 days since maximum

Introduction - contd

- The 1985 outburst (1985 Jan 26) was well studied in all wavelengths from the X-rays to the radio
- Radio and early X-ray emission – non-thermal origin
- The radio, X-ray and the coronal lines arise in a region that is shock heated as the ejected envelope expands supersonically into the circumstellar matter accumulated through steady stellar wind (Gorbatskii 1972, 1973; Bode & Kahn 1985)

The 2006 Outburst

RS Oph discovered in outburst again, after a gap of 21 years, on 2006 Feb 12.9, at a magnitude of 4.4

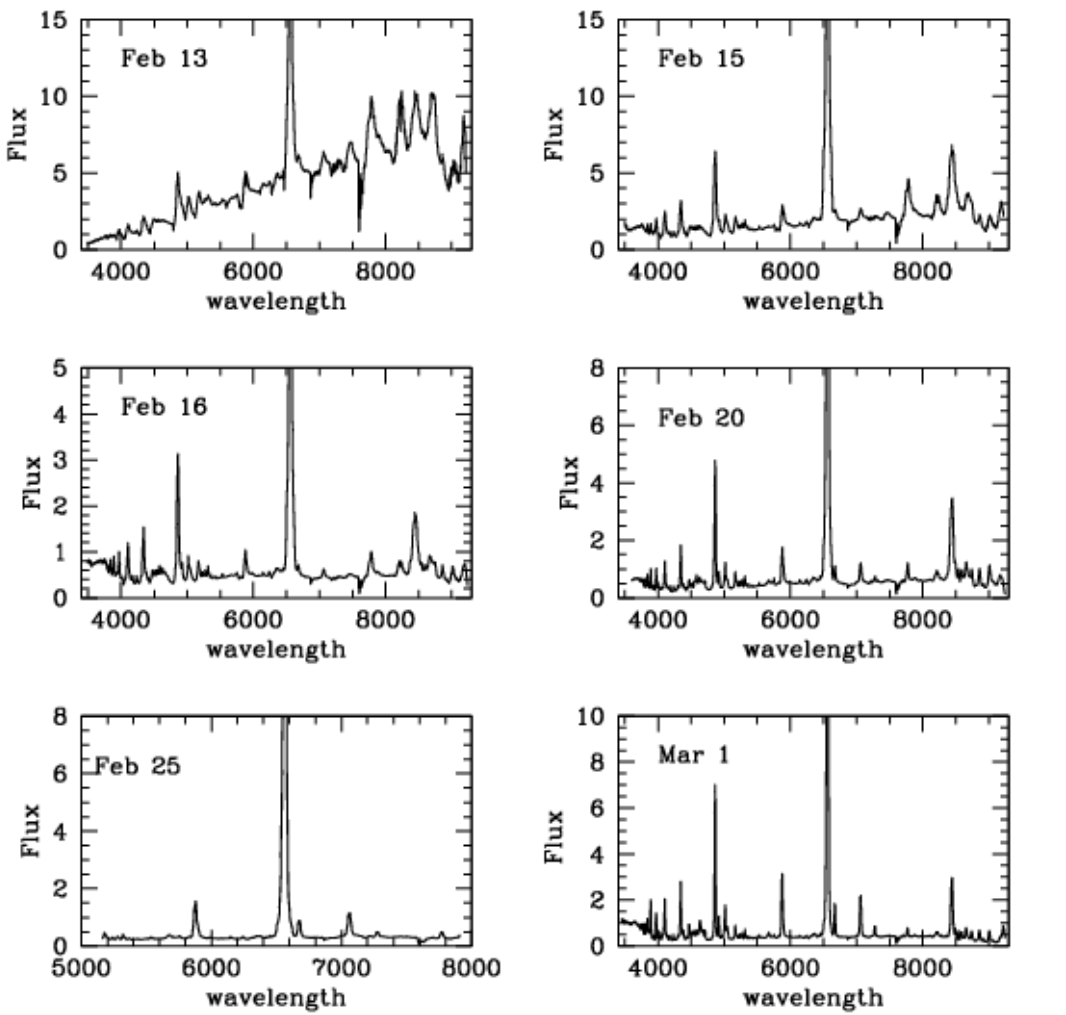


Observations

- Optical monitoring using VBT and HCT from Feb 13 onwards

  low resolution using HCT and VBT and immediate post-maximum high resolution echelle spectra using VBT
- Radio observations using the GMRT – concerted with the high frequency radio observations using the VLA, MERLIN, EVN

Optical spectroscopy



Early spectrum – P Cyg profiles
Broad emission lines
Expansion velocity ~4000 km/s

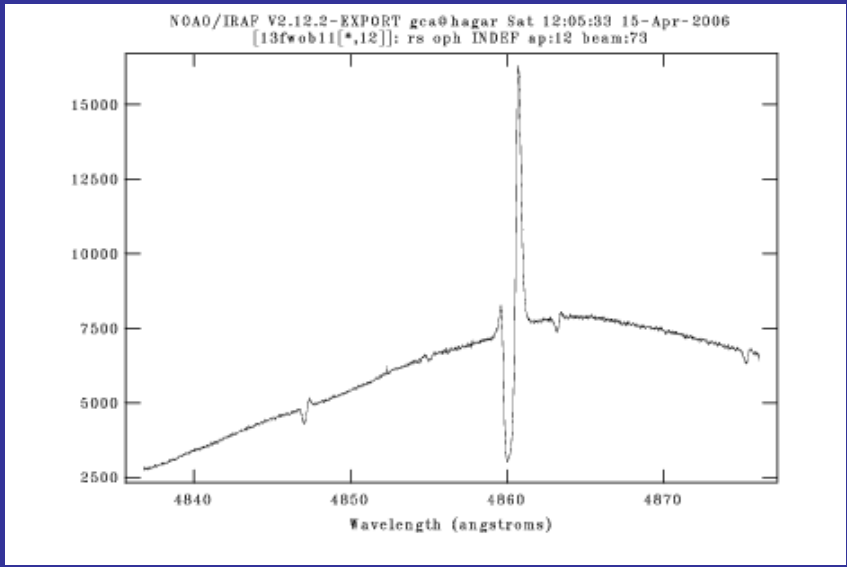
Feb 13.9 – strong Nitrogen lines, red continuum which turned bluer later

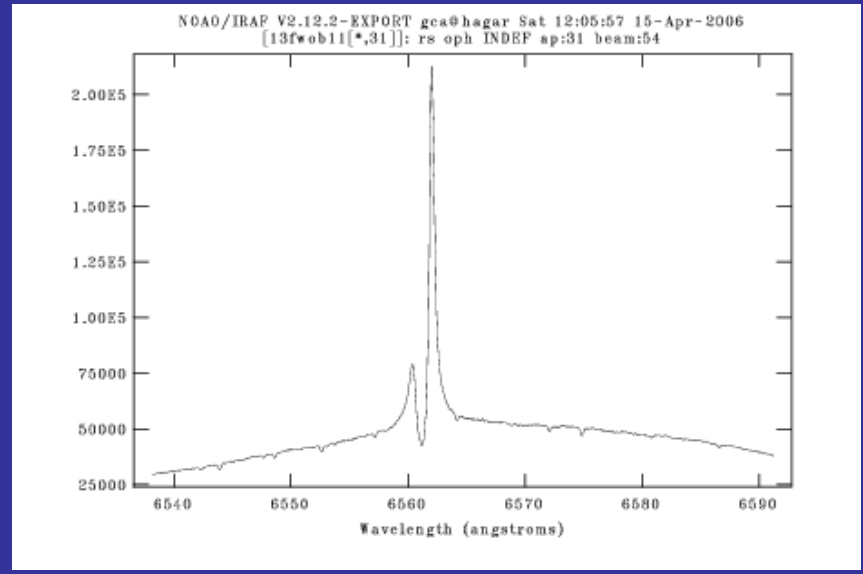
P Cyg absorption decreases, emission lines narrow with time

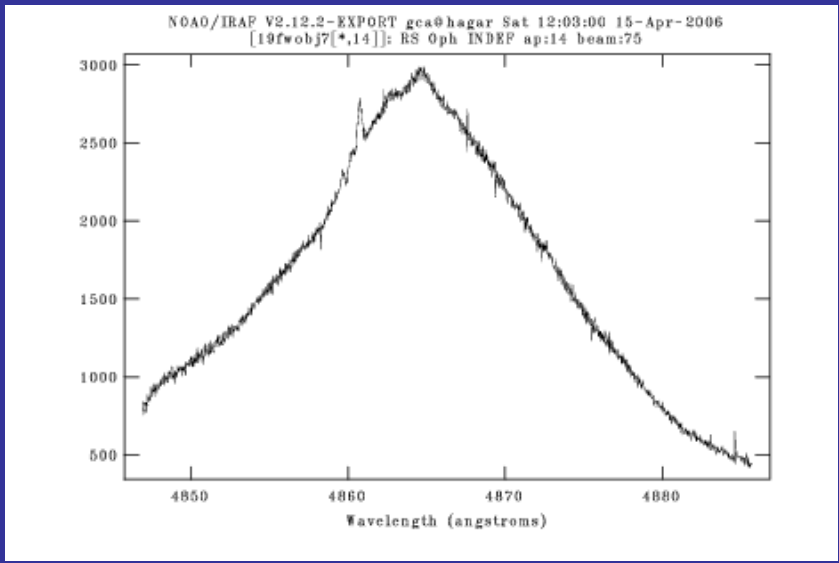
Coronal lines detected in spectrum obtained on Feb 16, 4 days since outburst (~18 days in 1985)

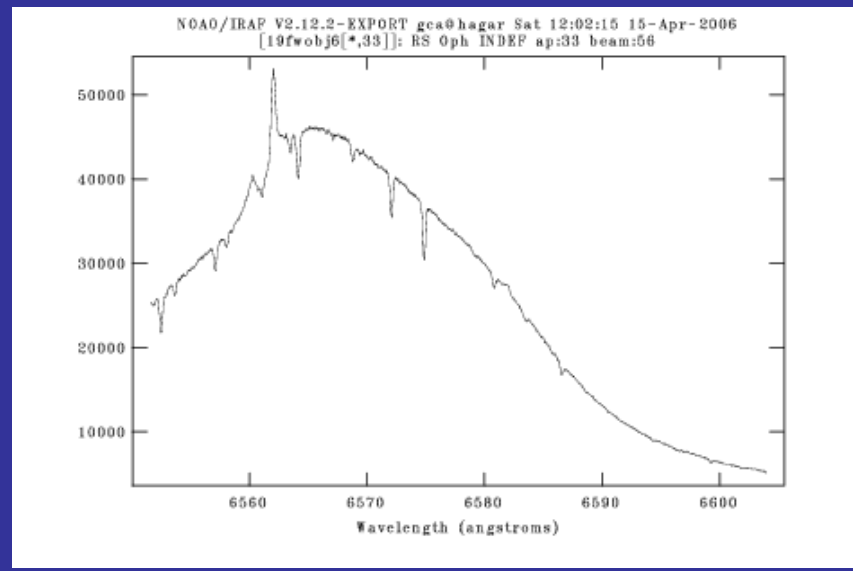
He I lines develop and strengthen with time

Early time Balmer line profiles

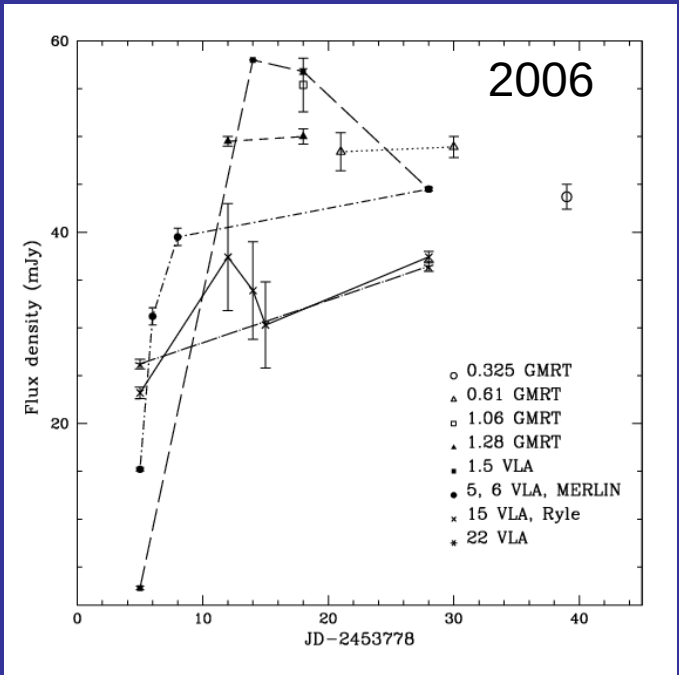


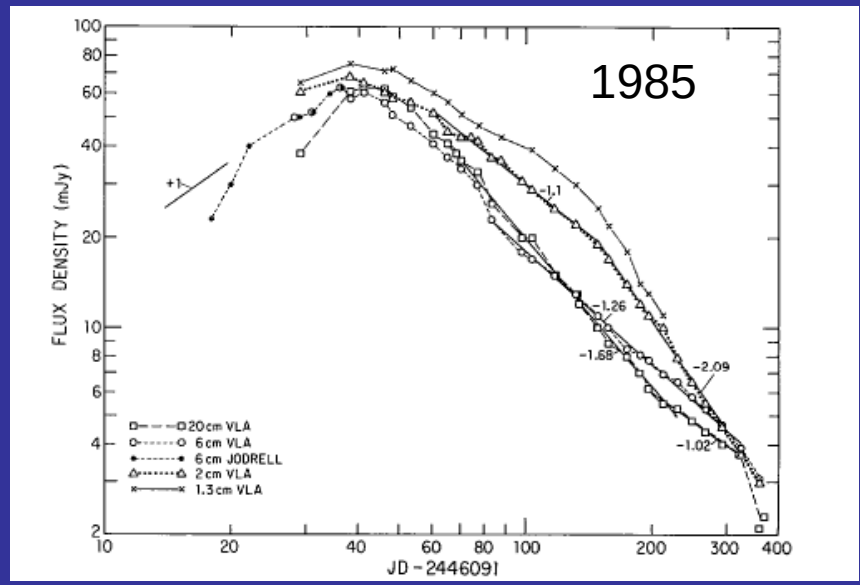






Radio emission





Radio emission turned on early, 3 days since outburst, compared to ~14 days since outburst in 1985

Initial rise steep, slow rise / flattening in the light curve after ~ day 10, except in the 1.5 GHz which shows a decline

Radio emission detected in the low frequencies – not detected in the low frequencies (0.325 GHz) during the 1985 outburst

EVN observations indicate east-west extended emission, possibility of 3 components, one non-thermal

X-ray observations (SWIFT and RXTE) also indicate an early turn on
(cf. Sokolski et al., Orborne et al.)

RXTE observations (2-20 keV) - Hard X-rays detected on Feb 15, ~ 3 days since outburst – consistent with the x-ray emission arising from nebular remnant that has been shock-heated by ejecta moving at a velocity around ~ 3000 km/s.
Harder than that detected by EXOSAT during the 1985 outburst, several months after the outburst.
Spectrum softened by Feb 18. Source continued to soften and began fading by Feb 22
Feb 27 observations indicate hard x-rays characterized by thermal emission

SWIFT observations (0.3-10 keV) – also indicate a decrease in the flux levels from Feb 21.
Observations on March 13.8 indicate an increase in the flux below 0.6 keV – appears consistent with a hot white dwarf

Optical, Radio and X-ray observations of the 2006 outburst indicate an early interaction of the nova ejecta with the circumstellar material

Monitoring in all wavebands continuing

Collaborators:

- Optical Observations - S. Muneer, G. Pandey, G. Selvakumar (VBT)

  B.C. Bhatt, P.S. Parihar, D.K. Sahu (HCT)

- Radio – N.G. Kantharia, S.P. Eyres, M.F. Bode,

  T. J. O'Brien

Also thank all the VBT and HCT observers who kindly spared part of their observing time for the observations of RS Oph