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CSS091215:060708-060335 : AN OPTICALLY EMERGENT ERUPTIVE NEAR THE HEAD OF HERBIG HARO 866 WEST

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CSS091215:060708-060335 (α_{2000} = $06^{h}07^{m}08^{s}.1$; δ_{2000} =-06°03′35″ good to one arcsecond).

Public Catalina RealTime Transient Survey optical data (Drake *et al.*, 2009) reveal a faint and slowly brightening object which was first detected in Autumn 2006 whilst not having been detected previously in unfiltered optical data from the Catalina Sky Survey 0.7 meter telescope (albeit with gaps) back to January 2005, as illustrated in Figure 1 and provided in Table 1 (available through the IBVS website as `5921-t1.txt`).

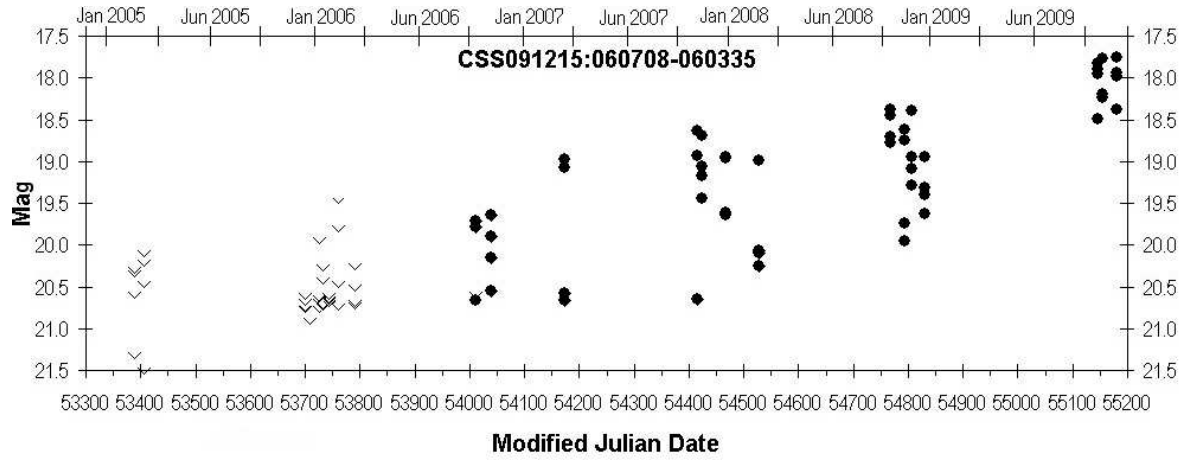

Figure 1. CRTS observations of CSS091215:060708-060335, filled circles are measurements, 'V' symbols are upper limits. Errors on each measure range from nearly a quarter up to at most half a magnitude

Investigation of archival POSS I and SERC/AAO Schmidt red and blue plates showed nothing in the region down to limiting magnitudes of 20 to 21. Images from the 2MASS All Sky Survey (Skrutskie *et al.*, 2006) show an object just visible in the J band, however it begins to appear more firmly in the H band and is most evident in the K_s band all from images taken in November 1998, lying very adjacent to the 2MASS Extended Catalog object 2MASX J06070812-0603352. SPITZER IRAC 3.6, 4.5, 5.8 and 8.0 micron March 2005 images (Werner *et al.*, 2004) also show the object well, but it is not evident on the same date MIPS 24 micron image, although apparently appearing on the 70 micron image, however this image does not cover the whole field (Figure 2). The extended object is always most evident around the two to four micron passbands, being faint to invisible at longer and shorter wavelengths, with public April 2007 AKARI mission images

(Murakami, H. *et al.*, 2007), for example, showing it best at 3.2 and 4.1 microns and barely present at 7.0 microns, whilst HH 866 becomes increasingly much brighter towards the longer passbands (Figure 3).

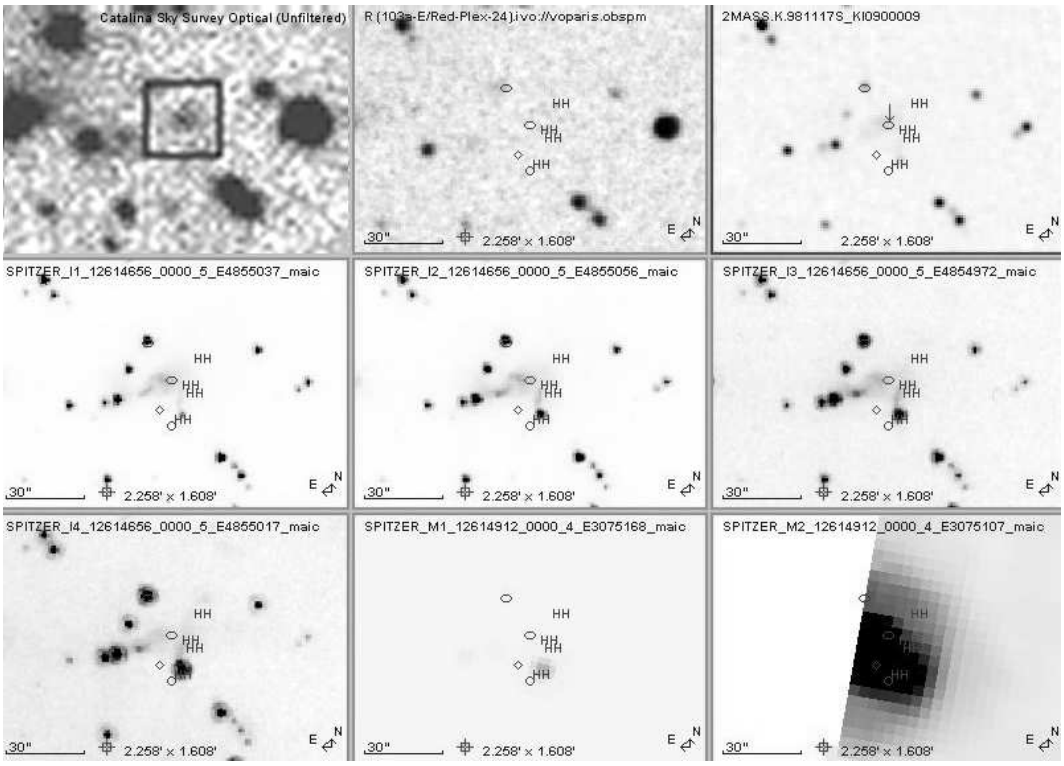

Figure 2. Optical and SPITZER IRAC and MIPS images of the region surrounding CSS091215:060708-060335. From left to right, in top to bottom rows, CSS 0.7m Telescope unfiltered optical image, POSS I E (red) plate image, 2MASS K_s image, SPITZER IRAC 3.6, 4.5, 5.8 and 8.0 micron images, SPITZER MIPS 24 and 70 micron images. The arrow in the 2MASS image points to the CRTS object position, HH denotes Herbig Haro objects with HH 866 southmost. The ellipses are 2MASX objects shown at centre and Northeast of centre respectively, the diamond denotes the SIMBAD position for IRAS 06046-0603, the circle the SIMBAD position for [C2001b] 11, with all images orientated and scaled via Aladin, except for the CRTS image which was done by hand

Wang et al. (2005) imaged the region of this suspected embedded infrared cluster, [C2000b] 11 (Carpenter, 2000), as part of a search for Herbig Haro Objects in the more general Monoceros R2 region, finding in particular one just South of this position detected in [SII] and Hα images which they denoted HH 866. Hodapp (2007) examined this object and the area immediately around [C2000b] 11 (amongst others) in more detail using UKIRT WFCAM K band images in October 2005. Hodapp (2007) classifies the main HH 866 as HH 866 West to differentiate it from a newly detected East object, and as can be seen in Figure 17 of that paper, and the image also reveals an extended region extending slightly East from the tip of the North-South aligned HH 866 jet. Hodapp (2007) further notes :

"To the east of this position is a large, rather poorly defined bow shock at $6^{\rm h}7^{\rm m}08\overset{\rm s}{.}1$, $-6°03'36''$ that appears to be associated with more shock emission knots further east of it."

which lies within $1''$ of the CRTS position for CSS091215:060708-060335.

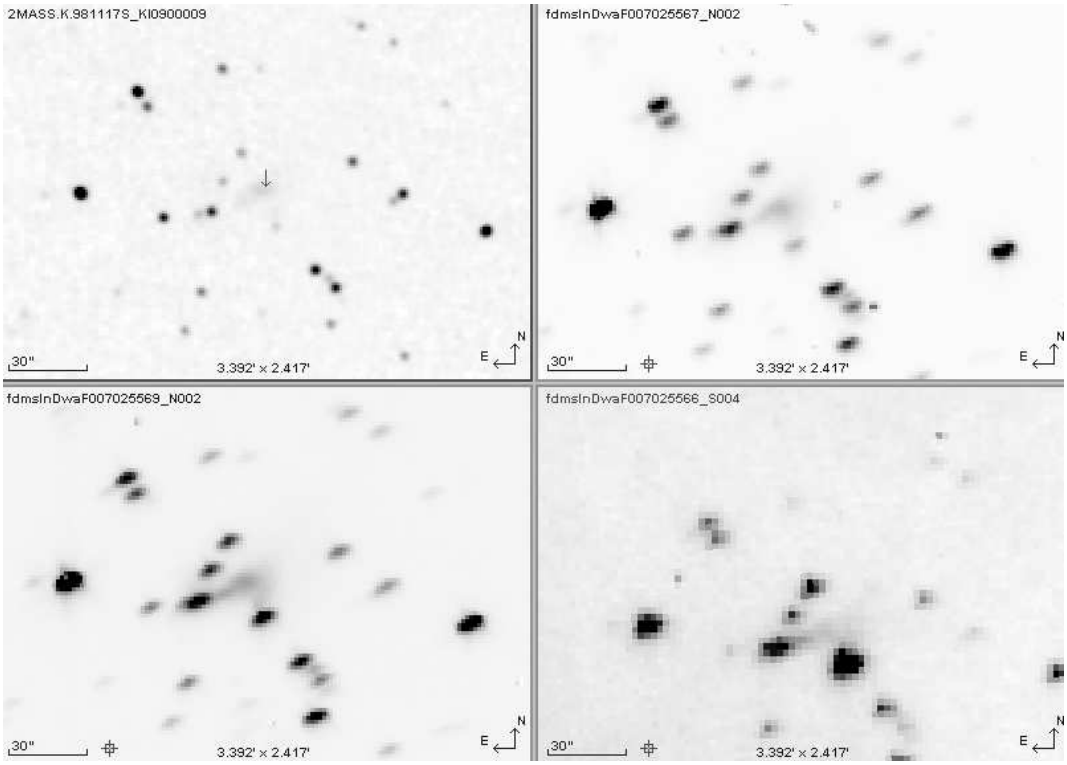

Figure 3. JAXA AKARI IRC images of the region surrounding CSS091215:060708-060335 in various passbands. From left to right, in top to bottom rows, 2MASS Ks positional reference image, AKARI IRC N3 3.2 micron image, N4 4.1 micron image and S7 7.0 micron image.

Given the general and immediate environments to CSS091215:060708-060335, its passband specific visibility, and its recent optical expression, it is possible that CSS091215:060708-060335 is an active pre-main sequence star currently emerging from the circumstellar material it is embedded within. In recent Catalina Sky Survey optical images the object appears stellar enough at core, albeit somewhat similar to a very compact nebulosity. Given the extent of the brightening so far, an increasingly illuminated knot of nebulosity is a possibility, but not a certain one given an absence of any evident illuminating star. Further, although the literature states both implicitly and at times explicitly that the various denoted Herbig Haro objects associated with HH 866 are being energised by the same object or region, said Herbig Haro objects appearing quite plainly and distinctly in emission line images, whilst there being no distinct object at the CRTS transient position in the same images, yet none of these various Herbig Haro objects can be seen in the CRTS image, which would mean this was a case of the energising object causing a new knot to brighten more than the other objects it impinges upon, with these somehow remaining unaffected.

An uninformative and very red optical spectrum having no sign of emission lines taken with the Palomar 5m telescope (Drake, A.J., pers. comm.) suggests that near infrared spectroscopy would be more suitable for discerning the character of this new transient.

Acknowledgements:

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