Supplementary Information for "A giant outburst two years before the core-collapse of a massive star" (Pastorello et al.)

1. Supplementary Methods

1.1 Astrometry

Accurate, relative astrometric calibration of the images obtained during the pre-explosion outburst and after the supernova explosion is critical for deciding on the positional coincidence of these two phenomena. The image obtained on 2006 Sep 21 by K. Itagaki (0.60-m f/5.7) was selected as the reference image as it is of good image quality and contains no trace of either UGC4904-V1 or SN2006jc. Four images containing UGC4904-V1 and two images containing SN2006jc were selected to be aligned to this reference image. Using the IRAF APPHOT package, we measured the centroid position for 21 bright stars visible in all seven images. From this, using the IRAF package GEOMAP, we derived geometric transformation functions for each of the images. In order to employ a general non-linear transformation, we selected a 2nd-order polynomial model with half cross terms to calculate the geometric alignment function. Finally the images were registered to the reference image using the IRAF package GEOTRAN.

The accurate measurement of the coordinates of UGC4904-V1 in the aligned images proved-out to be difficult due to the high background gradient from the underlying host galaxy. To remove the host galaxy contamination we subtracted the reference image from each of the aligned images prior to the position measurements. For this, the reference image was convolved to match the seeing conditions of the images containing UGC4904-V1, and the image intensity levels were matched using the Optimal Image Subtraction[31,32] method implemented in the ISIS2.2 package. For deriving the image matching parameters we selected 24x24 pixel regions around ten isolated stars nearby to UGC4904-V1. First order kernel variability was used to compensate for the effects of possible PSF variability and uncertainties in the image alignment, and the background was modeled using a 1st or 2nd order polynomial surface. The same image matching and subtraction procedures were also carried out for the two unfiltered images of 2006, Oct 8-9 containing SN2006jc.

The positions of UGC4904-V1 and SN2006jc were measured in the different aligned and subtracted images making use of three different methods, namely centroiding, Gaussian fitting, and optimal filtering, all implemented in the IRAF APPHOT package. The resulting pixel coordinates and the mean coordinates for each epoch are listed in Supplementary Table 1. The errors in the image alignment can be estimated from the RMS of the residuals from fitting the transformation function to the data points and are listed in the table. Average image alignment errors in *x/y* estimated in this way are 0.03/0.10 and 0.04/0.09 pixels for the UGC4904-V1 and the SN2006jc images, respectively. For UGC4904-V1 it was clear that the dominating source of uncertainty was the position measurement of the transient itself, whereas for the significantly brighter SN2006jc, the uncertainties from the position measurement and the image alignment were of a similar magnitude. We hence obtained the best estimates for the positions of UGC4904-V1 and SN 2006jc from a mean of the individual measurements, and adopted the standard error of the mean (SEM) as the uncertainty. For UGC4904-V1 we took the mean of the 12 individual measurements and the SEM is the standard deviation of these divided by $\sqrt{4}$ (the number of independent images). For SN 2006jc the standard deviation was calculated from the six individual measurements and the SEM calculated assuming two degrees of freedom, because we have only two independent images. These uncertainties include both the errors due to the image alignment and the actual position measurements for the outburst and the supernova. The final, average pixel coordinates of UGC4904-V1 were hence (472.68±0.12, 430.28±0.15) and for SN2006jc we found (472.66±0.06, 430.35±0.10). Thus the positions of UGC4904-V1 and SN2006jc are precisely coincident to within the uncertainties in the alignment technique which has a total uncertainty of 0.22 pixels. Given the pixel scale of 1.44 arcsec/pixel, the position of the transients formally differs by 0.1± 0.3 arcsec.

1.2 Data Reduction

All basic steps of data reduction were performed using tasks in the IRAF environment. Both photometric and spectroscopic images were pre-processed with the standard IRAF task CCDPROC (including bias, overscan, flat field corrections, and trimmed to the useful physical detector area).

Instrumental magnitudes of SN 2006jc have been measured with the PSF-fitting technique using a custom built DAOPHOT-based package (SNOoPY). This method provides reasonable results in the case of SN2006jc because the object was largely dominant over the host galaxy background. However in order to properly estimate the magnitudes of the transient UGC4904-V1 (which was significantly fainter than SN2006jc), we needed to remove the host galaxy contribution from the transient image using the numerous templates collected over the previous 2 years, when no transient source was visible at the current SN location. The subsequent transformation of instrumental magnitudes into standard Johnson-Bessell magnitudes was performed observing a number of photometric standard fields[33] during the same nights as the supernova observations. The final photometric zero-points were estimated for all nights comparing the magnitudes of a sequence of stars in the field of UGC4904 to the average magnitudes of the same stars obtained in a few, selected photometric nights. The unfiltered magnitudes of the transient UGC4904-V1 can be best compared to R-band magnitudes (due to the response curve of the CCD used for those observations), and are hence zero-point calibrated using the R-band average magnitudes of the same sequence of stars used to calibrate the magnitudes of SN2006jc. The complete photometric measurements of the two transients, UGC4904-V1 and SN2006jc, are reported in Supplementary Table 2.

Spectra of SN2006jc were obtained from the pre-processed frames by performing optimal extraction with the IRAF task APALL, and then wavelength calibrated using spectra of comparison lamps taken with identical instrumental configuration. The spectra were then flux calibrated using sensitivity functions derived from spectra of standard stars obtained during the same night as the supernova observation. The spectra of the same stars have been used also to remove the most offending telluric absorption bands from the supernova spectra. Finally, the supernova spectra were checked with the photometry and, in cases of discrepancy, the spectra were adjusted to match the photometric data. The log of the spectroscopic observations presented in this paper is in Supplementary Table 3.

2. Supplementary Discussion

2.1 The probability of a chance spatial coincidence

One could conjecture that the two events UGC4904-V1 and SN2006jc are spatially coincident by chance and that they are physically unrelated objects. This appears to us a particularly unlikely alternative as they both are rather rare events. If UGC4904-V1 was actually in UGC4904 then it is a very rare occurrence, as such LBV giant outbursts are uncommon, and a supernova with such a faint visual magnitude combined with a sharp decline rate (1.6 mags per 10 days) as seen in Fig. 2 (main manuscript) has never before been recorded. Also SN2006jc is a very peculiar supernova, and its spectral characteristics are very unusual. We can present some simple statistical arguments that strongly disfavour the spatial coincidence of two physically unrelated transients.

SN2006jc is certainly in the host UGC4904, as we see the absorption features due to the interstellar CaII H & K lines, at the same redshift as the optical nebular emission lines of the galaxy. If UGC4904-V1 is also in the galaxy it must have been either a faint supernova or a giant outburst of an LBV. Classical novae only reach magnitudes of $M_R \approx -10$ (Ref. 34), and there is no other known transient that could reach that magnitude. Hence in any one galaxy, we should determine the probability that two supernovae, or more correctly a supernova and LBV outburst, are spatially coincident. If we assume the rate of supernovae and LBV outbursts in any particular galaxy are the same at 1 per 100 yrs, and that typical nearby supernova searches (such as KAIT and most well equipped amateur efforts) typically have been working for 10 years, then the Poissonian probability that 2 or more supernovae (or LBVs, or any combination thereof) occur within a period of 10 years is p_{10}=0.0047.

At the distance of UGC4904 (25.8Mpc), a 0.3″ radius around SN2006jc corresponds to an area of 4300 pc^2. If we assume that the probability of a coincidental and unrelated event *P(coincidence)* within this area of a galaxy with typical radius of 5 kpc is simply the ratio of the areas times the event rate, then

$$P(coincidence)=(5.5\times10^{-5}\times p_{10})/\sin i$$

where sin$i$ corrects for the projection effects of galaxy inclination (*i = angle of inclination).* If we assume randomly inclined axes, and hence on average sin$i$ = 0.7, then P(coincidence)=3.7x10^{-7}. In other words, in the 10 years of focused searching for nearby supernovae the probability that any one, typical, galaxy has had two supernovae (or a supernova and an LBV) *and* that they are spatially coincident is 3.7x10^{-7}. If we assume a sample of 10000 galaxies are monitored by such supernova surveys[35], it would suggest a total probability that 2 supernovae are detected in any galaxy and are spatially coincident to be *P(total)*~3.7x10^{-3}. Admittedly we have used some general assumptions. We assumed a mean inclination angle, a mean supernova rate for galaxies, and assumed that events would be randomly distributed in a galaxy. The latter assumption could be compromised, as massive star explosive transients will obviously be more concentrated in the high star formation areas. The SN rate of 1 per 100 yrs is, within a factor of two, what we tend to observe locally[36]. On the other hand we have conservatively assumed that all supernovae that occur are actually discovered, and relaxed the coincidence time to 10 years rather than 2. In fact the probability that two supernovae are actually discovered in the same galaxy is significantly less than the theoretical Poissonian probability that they occur. To address these assumptions would require a detailed Monte Carlo simulation, for which the uncertainties in the sampling frequencies and the depths of observations from all the supernova surveys would have to be included, and at present they are not known accurately. Also the rate of LBV giant outbursts appear to be significantly lower than the rate of supernovae, as only ~5% of recent supernova candidate transients are classified as LBV outbursts[37]. Although we have made assumptions that could be questioned, on balance we have been conservative and would expect *P(total)* to be lower than we have estimated.

If UGC4904-V1 is a foreground transient we can estimate probabilities of coincidence. We assume it was a faint classical nova (CN). It has a very rapid decay rate even for “fast-nova”, which typically have decline rates of 0.5 mags per 10 days [34]. The “very fast” novae in M31 have decline rates similar to UGC4904-V1, so we assume conservatively that all novae in our galaxy are candidates. The rate of CNe in the Milky Way is 35 ± 11 yr^{-1} (Ref. 38), and hence in 100 years there have been around 3,500±1,100 CNe. In approximately 100 years of supernova searches there have been around 3,600 supernovae[35]. If we assume that CNe are isotropic, again a very conservative assumption as they will be concentrated in the disk and bulge (and UGC4904 has coordinates l=179° b= 44°), then the possibility of any CN being within our measurement uncertainty (0.3″ radius) of a single supernova is 6×10^{-13}, and hence around 2×10^{-9} for any supernova in the sample of 3,600. The rate of dwarf novae in the galaxy is uncertain. However given the number known, it is unlikely to differ from the CN rate by more than an order of magnitude[39]. Any galactic transient which would have a probability of more than about 1% of being coincident with *any* of the 3,600 supernovae would have to be $\sim10^7$ more common than CNe. We can think of none which are likely candidates. Clearly both of these illustrative calculations suggest a chance occurrence is very unlikely.

2.2 Properties of the host galaxy UGC4904: distance, reddening and metallicity

The distance to UGC4904 can currently only be estimated from the recessional velocity. The velocity of UGC4904 corrected for infall of the Local Group towards Virgo is 1,830 km s^{-1} (from the HyperLeda catalogue[40]) and adopting a Hubble constant of H_0=71 km s^{-1} Mpc^{-1} gives a distance of 25.8 ± 2.6 Mpc, where the uncertainty comes from the cosmic thermal velocity dispersion[41] of 187 km s^{-1}.

We adopt a foreground Galactic extinction[42] toward UGC4904 of E(B-V)=0.02± 0.02. We do not have an estimate of the internal host galaxy reddening towards SN2006jc. However we believe that it is likely to be small for three reasons. The spectrum is very blue, rising steeply towards the UV and one can compare an arbitrary, and unphysical, hot blackbody temperature (T_{BB}) to the dereddened continuum[43]. If the earliest spectrum of SN2006jc is dereddened with a standard reddening law characterized with a value *E(B-V)*>0.5, then even a blackbody of $T_{BB}=10^9$ K cannot match the steepness of the bluewards rising continuum. However a T_{BB} ~12,000K is more likely to be applicable, given the typical effective temperatures estimated for the expanding photospheres of core-collapse supernovae at early phases[44]. To approximately match the slope of a black body of T_{BB} =12,000K, the spectrum of SN2006jc needs to be dereddened by only *E(B-V)*=0.05. In addition, the detection of weak interstellar CaII H&K lines in the supernova spectra, attributed both to UGC4904 and our Galaxy, with comparably narrow equivalent widths (~0.1Å), makes the total extinction necessarily small. Finally, the galaxy itself is faint and blue, and SN2006jc occurred well away from the central regions and hence it appears unlikely there is significant internal dust extinction. With these motivations, we have adopted in this paper a relatively small value for the total reddening, *E(B-V)*=0.05.

The host galaxy was observed spectroscopically in the Sloan Digital Sky Survey and the emission line strengths are available through DR5[45]. An estimate of the nebular oxygen abundance of UGC4904 can be determined from the [OIII] and [NII] line strengths (using calibrations discussed in Ref. 46) giving 12+log(O/H) = 8.30±0.11 dex (or a global metallicity of 0.5$Z_{\odot}$). The absolute magnitude of UGC4904 ($M_B \approx$ -16.0) similar to the Small Magellanic Cloud, and hence a low metallicity is expected from the well established mass-metallicity relation[47]. Hence it appears that the environment of SN2006jc is mildly metal deficient, somewhat similar to the massive stars in the Large Magellanic Cloud, which has an oxygen abundance of 8.35±0.10 dex[48].

2.3 Might SN2006jc be an LBV-like super-outburst?

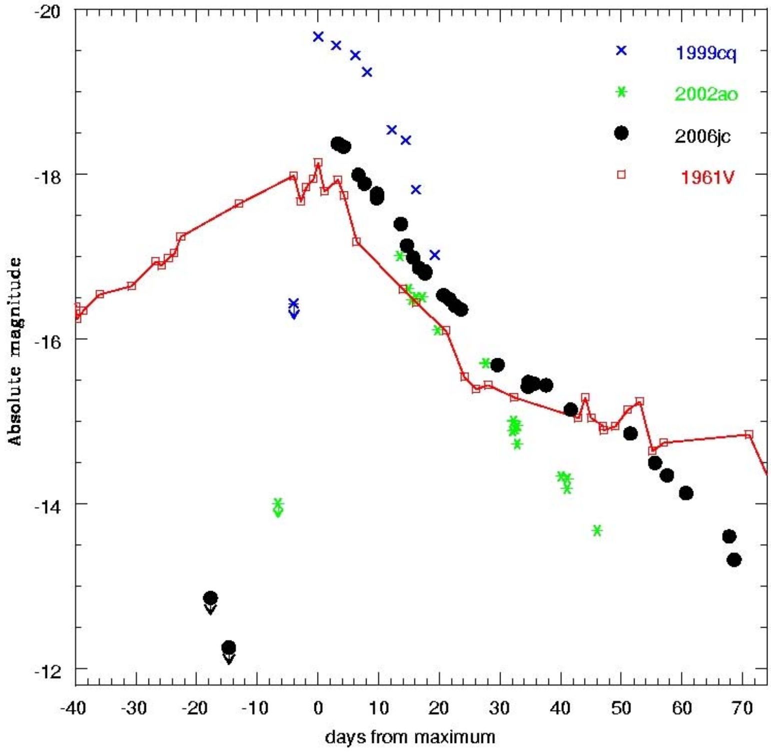
Some doubts on the real nature of SN2006jc may arise from the peculiar characteristics of its spectra. Together with the narrow HeI lines, the spectra have a very sharp, blue continuum and, at the red wavelengths, broad lines showing an unusual profile, which do not show the clear P-Cygni absorptions expected in a young Type Ib/c SN.

As an alternative scenario to a supernova explosion, one might claim that SN2006jc is a further, exceptional LBV-like outburst occurring 2 years after UGC4904-V1, and about 4 magnitudes more luminous than that event. The magnitude at maximum of SN2006jc is indeed similar to that observed in the brightest super-outburst observed so far, i.e. SN1961V, although the real nature of this event (super-outburst of an LBV or genuine supernova explosion) is still debated[49-51]. SN2006jc and SN1961V show a similar post-maximum decline of the light curve, but the rising phase to the maximum light is definitely slower in SN1961V, increasing by only ~2 magnitudes in about 40 days[52,53]. As shown in Supplementary Figure 1, if we adopt the light curve of SN1999cq[11] as a template, SN2006jc would have a very steep rise to the maximum, increasing by >3 magnitudes in about 4 days. Without invoking an analogy between the light curves of SN1999cq and SN2006jc, the deep detection limit obtained before the discovery of SN2006jc indicates that this event rose by about 6 magnitudes in about 20 days, so much more rapidly than SN1961V.

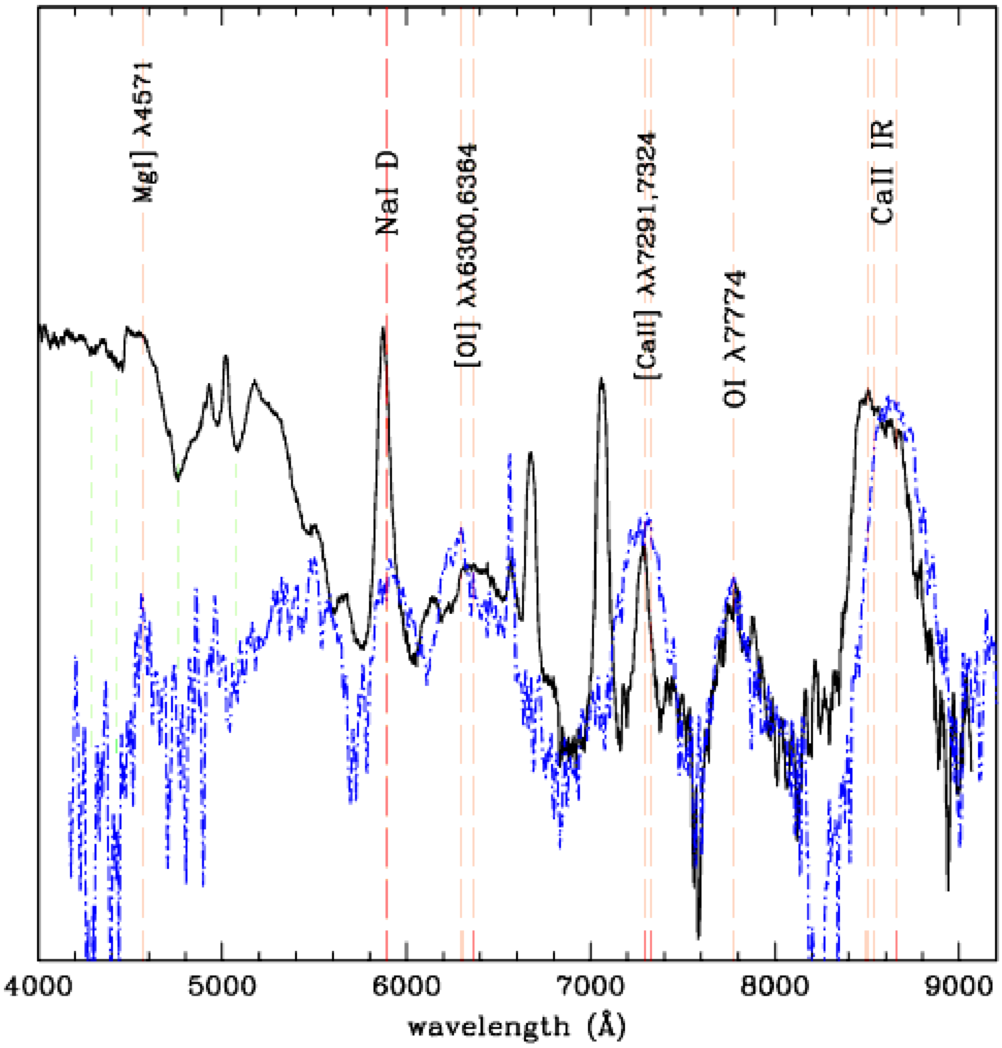
Moreover, there is no clear spectral similarity between SN2006jc and SN1961V. Spectra of SN1961V[53,54] are dominated by prominent, narrow H and HeI emission lines, and there is no evidence of any broad features. However, since the spectra of SN1961V lack a proper flux calibration, it is impossible to verify if they showed a strong, blue continuum, similar to that observed in SN2006jc. Therefore we find no definite similarity between SN2006jc and the putative super-outburst SN1961V.

On the contrary SN2006jc shows many features in common with Type Ic supernovae. Again, the maximum luminosity and the post-maximum decline of the light curve are not rather similar to those of the Type Ic SN2006aj (as shown in Figure 2), and the fast pre-maximum rise might be the result of strong interaction with a CSM, analogous to the fast rise to maximum occasionally observed in some Type IIn supernovae (e.g. SN1994W[55]). The similarity with a normal Type Ic becomes more evident if we compare the latest spectrum available for SN2006jc with that of the normal Type Ic SN1988L[56] (Supplementary Figure 2). Most of the broad spectral features are visible in both spectra, although the extremely blue continuum remains a peculiarity of SN2006jc and the few similar events[10,11], although already observed in several CSM-interacting supernovae (e.g. SN 1997cy[57] and SN 1999E[58]).

Supplementary Figure 1 | Comparison of the absolute light curves of SN2006jc (and the similar SN1999cq and SN2002ao) with the putative LBV super-outburst SN1961V. Despite the peak luminosity and post-maximum light decline of SN2006jc are similar to those of SN1961V[52,53], its pre-maximum rise (as well as those of the two similar objects[10,11,24]) is much faster than in SN1961V, showing that these events are not alike.



Supplementary Figure 2: Comparison between a spectrum of SN2006jc and that of the normal, non-interacting supernova type Ic SN1988L approaching the nebular phase. The spectrum of SN2006jc is at phase +35.37 days from discovery; that of SN1988L (rescaled to the flux of the spectrum of SN2006jc) was obtained on June 06, 1988 and is shown in Reference 56. This spectrum shows the typical features of a Type Ic supernova during the transition between the photospheric and the nebular phase. The most important broad emission lines are marked with a long-dashed red line (and identified); the main absorption features are indicated with a short-dashed green line. Most of the broad features are visible in the two spectra. However, a remarkable difference is that the [OI] $\lambda\lambda$6,300-6,364 and [CaII] $\lambda\lambda$7,291-7,324 classical nebular emission featuress are still missing in the spectrum of SN2006jc, indicating at this epoch the supernova has not entered the nebular phase yet.



2.4 Evidence of circumstellar shells and possible relation with the 2004 outburst.

The prominent, moderately narrow (~2,200 km s^{-1}) HeI emission lines visible in the spectra of SN 2006jc give unequivocal evidence for the presence of a massive He-rich shell ejected by the progenitor of this supernova (see also Ref. 10). These lines are possibly produced by the interaction between the supernova ejecta (expanding at a velocity of 4,000-9,000 km s^{-1}) and a CSM expanding at a velocity of about 2,200 km s^{-1}. Such a shocked CS shell, moving at 2,200 km s^{-1}, could have been already reached by the supernova ejecta only if it was produced by a mass-loss episode closer in time than the 2004 outburst.

Alternatively, narrow circumstellar lines superimposed on the broad-lined supernova spectrum can also be produced in undisturbed CS gas photoionized by the initial UV/X-ray flash. If the impact between supernova ejecta and CSM is not occurred yet, it is still possible that this material has been produced in the 2004 outburst event. However, the unusual strength of the HeI lines and their long-life make very unlikely the photoionization mechanism.

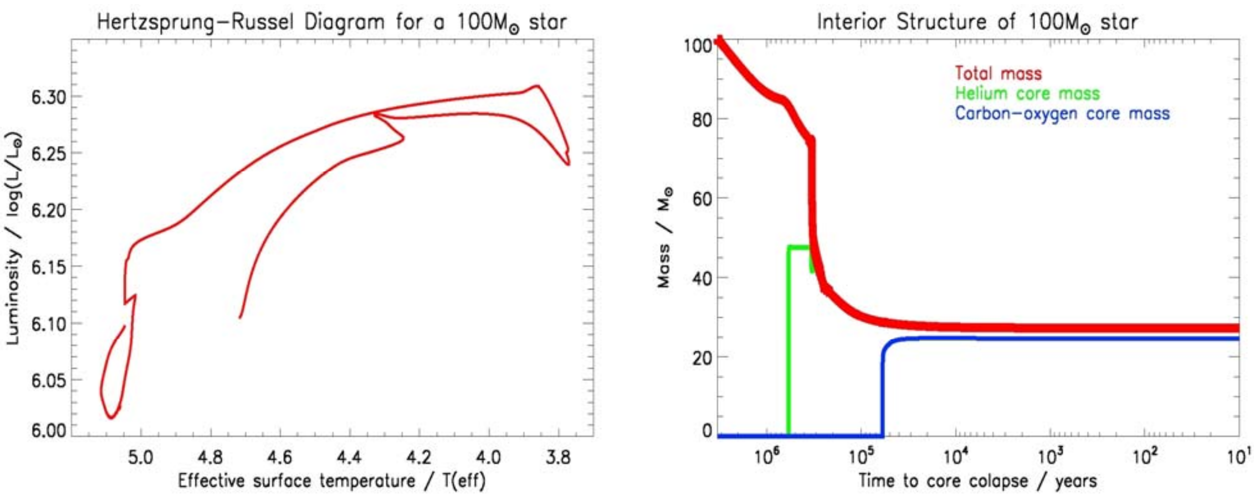
Additional information comes from the two higher resolution WHT spectra, in which a second circumstellar component, visible as narrow, blue-shifted absorption lines of HeI and OI, was detected. Another narrow unresolved P-Cygni feature, probably Hα, is also detected in most of the early spectra. Hα is also visible in net emission in the latest spectra. This suggests that some hydrogen is present in the CSM environment of SN2006jc. All these very narrow features are indicative of the presence of at least one further slow-moving (~500 km s^{-1}) circumstellar shell. Such narrow P-Cygni absorptions are not unusual, having been already detected in a number of Type IIn supernovae (e.g. 1994W[55], 1994aj[59], 1995G[60], 1996L[61], 1997ab[62], 1997eg[63]), and proving that undisturbed circumstellar shells are frequently observed in the environment of many core-collapse supernovae. Recurrent mass loss episodes forming the complex CSM of SN2006jc are also in a good agreement with a massive LBV (or post-LBV) scenario for the precursor of this supernova.

As an alternative to a multi-shell environment, we might invoke a clumpy CSM [64] having a moderate pre-interaction bulk velocity of ~500 km s^{-1}, in which the 2,200 km s^{-1} HeI lines may be explained by the shock velocity inside individual He-rich clumps. However, a detailed study of the structure of the circumstellar environment of SN2006jc is beyond the aim of this paper and it will be more extensively discussed in a forthcoming paper.

2.5 Stellar evolutionary models of 60-100$M_{\odot}$ stars

We have calculated stellar models of 60$M_{\odot}$ and 100$M_{\odot}$ stars using the STARS code[1,65], in particular to determine the carbon-oxygen core mass before core-collapse. As an example, the evolutionary track for a 100$M_{\odot}$ star is shown in Supplementary Figure 3. The mass-loss prescription used is that of scheme D in Ref. 1, which is not sporadic and episodic as we suggest occurred for the progenitor of SN2006jc. The mass-loss mechanism, which removes the outer hydrogen and helium envelopes could be episodic or steady, or a combination of both, but whatever it is will not significantly change the mass of the carbon-oxygen core left. As SN2006jc has the characteristic features of a Type Ic supernova, it is likely the progenitor was the bare carbon-oxygen core of this 60-100$M_{\odot}$ star. We estimate the mass of the core to be 15-25$M_{\odot}$ at the end of core carbon burning. With such a large core mass, the formation of a black hole is predicted rather than a neutron star[1,2,17]. This is in contrast to recent estimates of the ejected mass from the Type Ic SN2006aj. The light curves of these 2 events are reasonably similar, as shown in Figure 2, but Ref. 28 suggests only 2$M_{\odot}$ of ejecta for SN2006aj, and that this arose in the core of a star of original mass 20-25$M_{\odot}$. The largest amount of ejecta estimated for any Type Ic supernova so far is about 13$M_{\odot}$ for SN2003lw[66], which was estimated to originate in a star of original mass of around 40-50$M_{\odot}$. Similarly massive ejecta (about 11$M_{\odot}$) were obtained for SN1998bw, with a main-sequence mass of 40$M_{\odot}$ [67]. The giant outburst of UGC4904-V1, similar to those observed for a number of LBVs (Figure 4; see also Supplementary Table 4). If the 2004 outburst and SN2006jc are events produced by the same progenitor star (and not e.g. by two different stars belonging to a binary system, see discussion in the main paper), the natural consequence is that the progenitor star must have been very massive, as there is no precedent for stars even in the 30-60$M_{\odot}$ range to show such luminosities in the LBV phase. Hence this is perhaps one of the largest cores we have witnessed undergoing core-collapse.

1. **Supplementary Figure 3 | Hertzsprung-Russel Diagram (left) and interior structure (right) of a 100$M_{\odot}$ star.**



3. Supplementary Tables

Supplementary Table 1: Position measurements for the outburst and the supernova. The positions of the transients from measurements using three different methods are listed. The *x* and *y* RMS of the residuals from fitting a transformation function between the data points of each epoch and the reference image are listed in the 6th and 7th column (in pixels).

Epoch	Object	Centroid	Gauss	Ofilter	Mean	Fit x_{RMS}	Fit y_{RMS}
2004 Oct 15	UGC4904-V1	472.90, 429.84	472.87, 429.92	472.89, 429.92	472.89, 429.89	0.033	0.111
2004 Oct 16	UGC4904-V1	472.57, 430.20	472.50, 430.28	472.55, 430.28	472.54, 430.25	0.025	0.102
2004 Oct 18	UGC4904-V1	472.87, 430.51	472.85, 430.62	472.86, 430.62	472.86, 430.58	0.028	0.102
2004 Oct 22	UGC4904-V1	472.40, 430.35	472.40, 430.41	472.42, 430.45	472.41, 430.40	0.023	0.103
2006 Oct 09	SN2006jc	472.69, 430.49	472.56, 430.43	472.54, 430.52	472.60, 430.48	0.043	0.085
2006 Oct 11	SN2006jc	472.74, 430.22	472.71, 430.22	472.71, 430.23	472.72, 430.22	0.044	0.086

Supplementary Table 2 : Photometry of the outburst UGC4904-V1 and SN2006jc. Images from the 0.6m Itagaki telescope and from the 0.35m Boles reflector telescope were unfiltered and the response curve of the CCD used suggests that the unfiltered magnitudes are best compared to the R band photometry. Hence they are listed under the R column, although the difference should be recognised. The instruments used in the photometric observations of SN2006jc are the 3.58m Telescopio Nazionale Galileo, the 2.0m Liverpool Telescope and the 2.56m Nordic Optical Telescope in La Palma (Canary Islands, Spain) and the 1.82m Copernico Telescope of Mt. Ekar (Asiago, Italy).

Date	JD	Telescope	*U*	*B*	*V*	*R*	*I*
2004 Jan 12	2,453,016.52	Boles 0.35m				*>18.5*	

2004 Mar 01	2,453,066.39	Boles 0.35m				*>18.7*	
2004 Apr 17	2,453,113.44	Boles 0.35m				*>19.0*	
2004 Sep 17	2,453,266.27	Itagaki 0.6m				>19.0	
2004 Sep 30	2,453,279.27	Itagaki 0.6m				>19.0	
2004 Oct 14	2,453,293.32	Itagaki 0.6m				18.05 (0.23)	
2004 Oct 15	2,453,294.31	Itagaki 0.6m				18.73 (0.19)	
2004 Oct 16	2,453,295.32	Itagaki 0.6m				19.13 (0.19)	
2004 Oct 21	2,453,300.33	Itagaki 0.6m				19.35 (0.15)	
2004 Oct 23	2,453,302.27	Itagaki 0.6m				19.47 (0.17)	
2004 Nov 07	2,453,317.22	Itagaki 0.6m				>20.2	
2004 Nov 08	2,453,318.34	Itagaki 0.6m				>19.8	
2004 Nov 09	2,453,319.26	Itagaki 0.6m				>19.6	
2004 Nov 22	2,453,332.17	Itagaki 0.6m				>20.1	
2005 Jan 05	2,453,375.58	Boles 0.35m				>19.2	
2005 Apr 10	2,453,471.46	Boles 0.35m				>18.7	
2005 Nov 10	2,453,684.60	Boles 0.35m				>19.0	
2005 Nov 24	2,453,699.31	Itagaki 0.6m				>19.5	
2005 Dec 11	2,453,716	CBET 666				>19.8	
2006 Jan 29	2,453,764.67	Boles 0.35m				>18.7	

Supplementary Table 2 : Photometry of the outburst UGC4904-V1 and SN2006jc.
Continued.

Date	JD	Telescope	U	B	V	R	I
2006 Feb 24	2,453,791.12	Itagaki 0.6m				>19.7	
2006 Mar 03	2,453,798.38	Boles 0.35m				> 18.6	
2006 Sep 18	2,453,997.28	Itagaki 0.6m				> 19.3	
2006 Sep 21	2,454,000.30	Itagaki 0.6m				> 19.9	
2006 Oct 09	2,454,018.27	Itagaki 0.6m				13.80 (0.03)	
2006 Oct 10	2,454,019.28	Itagaki 0.6m				13.84 (0.03)	
2006 Oct 13	2,454,021.66	LT + RATCAM	13.24 (0.01)	14.13 (0.01)	14.28 (0.01)	14.18 (0.01)	13.91 (0.01)
2006 Oct 14	2,454,022.68	LT + RATCAM	13.22 (0.01)	14.19 (0.01)	14.33 (0.01)	14.29 (0.01)	14.02 (0.01)
2006 Oct 16	2,454,024.68	NOT + ALFOSC		14.27 (0.01)	14.48 (0.01)	14.46 (0.01)	14.11 (0.01)

2006 Oct 16	2,454,024.70	Ek1.82 + AFOSC		14.27 (0.02)	14.46 (0.02)	14.41 (0.03)	14.08 (0.06)
2006 Oct 20	2,454,028.65	LT + RATCAM	13.70 (0.01)	14.62 (0.01)	14.70 (0.01)	14.78 (0.01)	14.60 (0.01)
2006 Oct 21	2,454,029.64	LT + RATCAM	13.73 (0.01)	14.69 (0.01)	14.90 (0.01)	15.04 (0.01)	14.63 (0.01)
2006 Oct 22	2,454,030.66	LT + RATCAM	13.88 (0.01)	14.78 (0.01)	15.00 (0.01)	15.19 (0.01)	14.75 (0.01)
2006 Oct 23	2,454,031.63	LT + RATCAM	13.94 (0.01)	14.86 (0.01)	15.13 (0.01)	15.31 (0.01)	14.86 (0.01)
2006 Oct 24	2,454,032.63	TNG + DOLORES	14.08 (0.02)	14.98 (0.01)	15.23 (0.02)	15.35 (0.01)	14.83 (0.01)
2006 Oct 24	2,454,032.63	LT + RATCAM	14.04 (0.01)	14.96 (0.01)	15.23 (0.01)	15.38 (0.01)	14.93 (0.01)
2006 Oct 27	2,454,035.66	Ek1.82 + AFOSC	14.47 (0.01)	15.23 (0.01)	15.53 (0.01)	15.64 (0.01)	15.17 (0.02)
2006 Oct 28	2,454,036.62	Ek1.82 + AFOSC	14.58 (0.01)	15.27 (0.01)	15.59 (0.02)	15.69 (0.02)	15.24 (0.01)
2006 Oct 29	2,454,037.61	Ek1.82 + AFOSC		15.40 (0.01)	15.64 (0.03)		
2006 Oct 29	2,454,037.62	Ek1.82 + AFOSC	14.77 (0.01)	15.39 (0.01)	15.65 (0.01)	15.77 (0.01)	15.32 (0.01)
2006 Oct 30	2,454,038.59	Ek1.82 + AFOSC		15.49 (0.02)	15.71 (0.03)	15.82 (0.03)	15.41 (0.02)
2006 Nov 05	2,454,044.60	LT + RATCAM	15.22 (0.07)	16.05 (0.08)	16.13 (0.03)	16.49 (0.03)	15.86 (0.02)
2006 Nov 10	2,454,049.58	NOT + ALFOSC	15.53 (0.03)	16.33 (0.02)	16.47 (0.02)	16.75 (0.02)	16.21 (0.01)
2006 Nov 10	2,454,049.64	LT + RATCAM	15.55 (0.01)	16.36 (0.01)	16.47 (0.01)	16.70 (0.01)	16.21 (0.01)

Supplementary Table 2 : Photometry of the outburst UGC4904-V1 and SN2006jc.
Continued.

Date	JD	Telescope	U	B	V	R	I
2006 Nov 11	2,454,050.58	LT + RATCAM	15.57 (0.05)	16.37 (0.03)	16.54 (0.06)	16.72 (0.07)	16.24 (0.06)
2006 Nov 13	2,454,052.59	Ek1.82 + AFOSC		16.46 (0.06)	16.63 (0.06)	16.74 (0.08)	16.25 (0.07)
2006 Nov 17	2,454,056.67	LT + RATCAM		16.64 (0.01)	16.83 (0.01)	17.03 (0.01)	
2006 Nov 26	2,454,066.47	Ek1.82 + AFOSC		17.13 (0.02)	17.29 (0.02)	17.32 (0.03)	16.77 (0.02)
2006 Dec 01	2,454,070.53	LT + RATCAM	16.46 (0.04)		17.49 (0.02)	17.68 (0.03)	17.02 (0.03)
2006 Dec 03	2,454,072.52	LT + RATCAM	16.66 (0.07)	17.46 (0.16)	17.64 (0.12)	17.83 (0.06)	17.11 (0.06)
2006 Dec 06	2,454,075.65	LT + RATCAM	16.96 (0.05)	17.74 (0.03)	17.87 (0.03)	18.04 (0.05)	17.18 (0.03)
2006 Dec 13	2,454,082.77	TNG + DOLORES	17.64 (0.02)	18.61 (0.02)	18.69 (0.03)	18.57 (0.03)	17.63 (0.04)
2006 Dec 14	2,454,083.58	LT + RATCAM	17.86 (0.10)	18.77 (0.05)	18.78 (0.05)	18.85 (0.04)	17.87 (0.04)

Supplementary Table 3: Log of the spectroscopic observations of SN2006jc.
Basic information on the spectra presented in this paper. The spectra have been obtained using the 3.58m Telescopio Nazionale Galileo, the 4.2m William Herschel Telescope and 2.56m Nordic Optical Telescope in La Palma; the 1.82m Copernico Telescope of Mt. Ekar; the 1.22m Galileo Telescope in Asiago-Pennar (Italy), the 1.93m Telescope of the Observatoire de Haute-Provence (St. Michel l' Observatoire, France) and the 2.16m NAOC Telescope of the Xinglong Observatory (China).

Date	JD	Phase from discovery	Instrument	Grism	Range (A)	Resolution (A)
Oct 12	2,454,020.73	+2.46	TNG+DOLORES	LR-B + LR-R	3,350-10,000	
Oct 16	2,454,024.69	+6.42	Ek1.82m+AFOSC	Gm4+Gm2	3,490-9,960	23-35
Oct 16	2,454,024.73	+6.46	WHT+ISIS	R600B+R316R	3,580-5,140, 5,440-8,400	2.7+5.0
Oct 16	2,454,025.38	+7.11	NAOC2.16m+BFOSC	Gm4	3,800-9,000	15
Oct 18	2,454,026.75	+8.48	WHT+ISIS	R600B+R316R	3,560-5,140, 5,440-8,120	2.7+5.0
Oct 23	2,454,031.74	+13.47	NOT+ALFOSC	Gm4	3,220-9,130	14
Oct 24	2,454,032.65	+14.38	TNG+DOLORES	LR-B + LR-R	3,360-10,000	13+13
Oct 25	2,454,033.65	+15.38	OHP+CARELEC	300 Tr/mm	3,690-7,320	8.5
Oct 26	2,454,034.67	+16.40	OHP+CARELEC	300 Tr/mm	3,690-7,320	8.5
Oct 27	2,454,035.63	+17.36	Ek1.82m+AFOSC	Gm4+Gm2	3,490-9,700	23-35
Oct 27	2,454,035.70	+17.43	As1.22m+B&C	300 Tr/mm	3,480-7,360	25
Oct 28	2,454,036.67	+18.40	Ek1.82m+AFOSC	Gm4	3,490-7,800	23
Oct 30	2,454,038.69	+20.42	Ek1.82m+AFOSC	Gm4	3,490-7,800	23
Nov 10	2,454,049.63	+31.36	NOT+ALFOSC	Gm4	3,280-9,120	14
Nov 14	2,454,053.64	+35.37	Ek1.82m+AFOSC	Gm4	3,500-7,820	23
Nov 27	2,454,066.56	+48.29	Ek1.82m+AFOSC	Gm4+Gm2	3,490-10,000	23-35
Dec 12	2,454,082.37	+64.10	NAOC2.16m+BFOSC	Gm4	3,890-7,300	15
Dec 14	2,454,083.58	+65.31	TNG+DOLORES	LR-B + LR-R	3,380-9,600	13+13

Supplementary Table 4: Outburst magnitudes, luminosities and masses of nearby LBV candidates and comparison with UGC4904-V1.
Note that SN2002kg (NGC2403-V37) was not a "giant outburst" but was part of a typical S-doradus phase shown by many stars in the LBV S-Doradus instability strip. The change in visual magnitude ΔM was due to a T_{eff} variations at constant luminosity, rather than a giant outburst accompanied by a genuine increase on M_{bol}.

Object	T_{eff}	Log L	M_{max}	ΔM	$M_{bol,max}$	Initial Mass (M)	Ref.
η Carinae	27,000	6.7	-14.5	4-6	-14	150±30	2
SN 1961V			-17	~6	-17	150-200	12
SN 1954J			-11	4	≤ -11.6	25-120	12
HD 5980	35,000	6.5	-10.5	~ 3	-13	120±25	68
NGC2363-V1	12,000	6.4	-10.4	> 4	-11.3	100±20	69
SN 1997bs			-13.8	5.7			70
SN 2000ch			-12.7				71
SN 2003gm			-13.7	5.4			30
P Cygni	2,000	5.9	-10.2	~ 2-3	~ -11	60	72
SN 2002kg	16,000	5.8	-10.2	~ 2	-10.5	40	12
UGC4904-V1			-14.1	> 2.15			this paper

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