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SN 1006: a thousand-year perspective

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Abstract. We review some of the extensive historical observations of SN 1006, emphasizing estimates of its brightness at maximum. An estimate of $V_{\rm max} \approx -7.5$ is consistent with what may be the most reasonable interpretation of these records and with an *a posteriori* calculation based on typical peak magnitudes for Type Ia supernovae together with the distance and extinction to SN 1006. We also give a brief overview of the discovery of the SN 1006 remnant in 1965, and contrast the earliest radio, optical, and X-ray observations of the remnant with recent ones, as reported in more detail by other papers in this JD09 review.

Keywords. stars: supernovae, individual (SN 1006), ISM: supernova remnants, history and philosophy of astronomy

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The supernova of 1006 CE, whose 1000th anniversary we mark through JD09, is generally regarded as the brightest supernova (and quite likely the brightest stellar event of any kind) ever recorded in human history. This star was so spectacular that contemporary observers throughout the northern hemisphere recorded the event, despite its southern location at Dec (1006) = 38°. (See papers by Stephenson and Sun for more details.) The *most* northerly sighting was from the Benedictine Abbey of St. Gall, in Switzerland at latitude 47.5° N. The chronicles of the abbey record a star *"dazzling to the eyes ... in the extreme limits of the south"*. These chronicles record the single most significant event of each year for more than three centuries. It is noteworthy that the writer gives such an extensive entry to this star – far more than he devotes to a 'famine more severe than any of our age' of the year before, or a deadly plague the year after (Fig. 1).

Records from around the world agree that the star first appeared on 1 May 2006, ± 1 day. But since these same records compare its brightness with Mars, Venus, the Moon, and even the Sun, there has been widespread disagreement about its peak brightness. The most explicit record is that of the Egyptian physician and astrologer Ali ibn Ridwan, who described it as *"2.5 or 3 times the magnitude of Venus, ... and a little more than a quarter of the brightness of the Moon"* (Goldstein 1965).

Two weeks after the star first appeared, when it should have been near peak brightness, Venus, the full Moon, and SN 1006 would all have appeared ∼ 15° above the horizon in different directions. Let us assume that ibn Ridwan was indeed referring to the *full* Moon ($V \approx -12.5$), and was using it and Venus ($V \approx -4$) as benchmarks for a logarithmic scale, similar to the modern magnitude scale (and to the response of the human eye). The result gives a magnitude $-7.3 > V_{\rm max} > -7.8$ for SN 1006 (Winkler *et al.* 2003 = WGL03).

According to Chinese records, SN 1006 remained visible for three years (Stephenson paper following). Records of its appearance continued to appear through the following centuries, but at some point European records conflated the 1006 C.E. event with one from 837 C.E., and as a result it became described as a comet, rather than a star. All of this was sorted out through the painstaking tracing of Arabic and other records by Bernhard Goldstein (1965), a young historian of astronomy at Yale, whose attention was drawn to the event by his friend Alistair Cameron. In a rocket flight the year before, Herbert Friedman's NRL group had identified the Crab Nebula (= SN 1054) as a strong X-ray

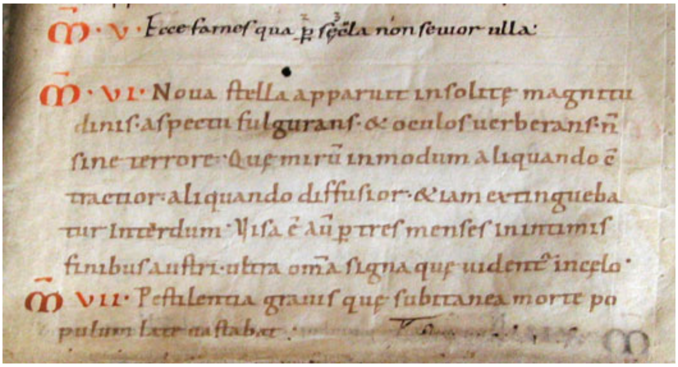
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Figure 1. Entries from the years 1005’ - 1007 from the chronicles of the Abbey of St. Gall, including an extensive reference to SN 1006. (Stiftsbibliothek St. Gallen)

source – the first cosmic X-ray source to be positively identified (Bowyer *et al.* 1964), and this had attracted speculation by Cameron and others that other historical supernovae might also be X-ray sources. Only a few months after Goldstein’s paper appeared, Gardner & Milne (1965) found that the radio source PKS 1459−41 = G327.6+14.6 was a polarized, non-thermal, shell-type radio source, and concluded that it was the probably remnant of SN 1006. (For a far fuller account of the recovery of SN 1006 as a remnant, see Devorkin 1985.)

A decade later X-ray (Winkler & Laird 1976) and optical (van den Bergh 1976) emission from SN 1006 was detected. Since then it has been much studied at all wavelengths, as several papers in this JD09 review. Among recent observations is a precise geometric measurement of the distance to SN 1006: 2.18 ± 0.08 kpc, based on measurement of the proper motions for the Balmer-dominated optical filaments delineating the NW region of the shell (WGL03), together with a measurement of the shock velocity based on spectra of the same filament by Ghavamian *et al.* (2002). WGL03 used this distance, the extinction of only $A_V = 0.31$ to the background Schweizer & Middleditch (1980) star, and the peak absolute magnitude for Type Ia supernovae of $M_V(\max) = -19.4 \pm 0.4$ to estimate that at its peak SN 1006 would have had $V(\max) \approx -7.5 \pm 0.5$, in remarkable agreement with the estimate based on the interpretation of the historical record outlined above.

In May of 1006, the star we now know as SN 1006 would have indeed been dazzling to the eyes, “*oculos verberans*,” and as several other papers in this Joint Discussion will show, observations of its unique remnant continue to dazzle (and sometimes confound) modern astronomers.

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