before the first SGR trigger and remained at maximum during the subsequent two triggers. Are the BATSE events related to the X-ray transient? For both the transient and SGR1900+14 the probability of being located inside the BATSE error box by chance is fairly small (~0.2% for assumed uniform sky distribution). As the positions for both SGR1900+14 and the transient are known with high accuracy (of the order of arcminutes) and they differ by more than ~1.5°, the KONUS events cannot be related to the Aquila transient. Moreover, a recent analysis indicates that there was no persistent X-ray emission (upper limit of ~100 μJy) from this region in the sky, during the 1979 SGR bursts. We conclude that it is improbable that the BATSE events originate from SGR1915+105.

Our results suggest that burst activity from the `old' SGR 1900+14 has been detected again ~13 years after its discovery. If our detection is indeed the recurrence of activity from this source, it shows that SGRs keep their ability to be active for many years. The extended duration of SGR activity strengthens the argument that these sources are related to galactic (possibly population I) objects, plausibly neutron stars. Recurrent SGR emissions do not signify a unique (catastrophic) event in the life cycle of the source, as is the case in the cosmological models currently favoured for the classical γ-ray bursts. If on the other hand, the new SGR is not related to the SGR1900+14, the case for the SGRs to be associated with population I objects becomes even stronger than it was before, with four (rather than three) sources following their distribution. This is very different from recent results on classical γ-ray bursts, for which a galactic disc origin is excluded. The long-term monitoring capability of BATSE gives hope of obtaining valuable information on the recurrence timescale of SGRs and (combined with other spacecraft) accurate source positions, which may lead to a better understanding of the nature of these objects.

Discovery of the candidate Kuiper belt object 1992 QB

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The apparent emptiness of the outer Solar System has been a long-standing puzzle for astronomers, as it contrasts markedly with the abundance of asteroids and short-period comets found closer to the Sun. One explanation for this might be that the orbits of distant objects are intrinsically short-lived, perhaps owing to the gravitational influence of the giant planets. Another possibility is that such objects are very faint, and thus they might easily go undetected. An early survey designed to detect distant objects culminated with the discovery of Pluto. More recently, similar surveys yielded the comet-like objects 2060 Chiron® and 5145 Pholus® beyond the orbit of Saturn. Here we report the discovery of a new object, 1992 QB, moving beyond the orbit of Neptune. We suggest that this may represent the first detection of a member of the Kuiper belt, the hypothesized population of objects beyond Neptune and a possible source of the short-period comets.

Our observations are part of a deep-imaging survey of the ecliptic, made with the University of Hawaii 2.2m telescope on Mauna Kea. The survey uses Tektronix 1,024 × 1,024 pixel and 2,048 × 2,048 pixel charge-coupled devices (CCDs) at the f/10 Cassegrain focus. Both CCDs have anti-reflection coatings which yield quantum efficiencies of ~90% at wavelength λ = 7,000 Å (K. Jim, personal communication). Survey observations are obtained in sets of four images per field with a total timebase of 2 or more hours. Each image is exposed for 900 s while autoguiding at sidereal rate. Because objects in the outer Solar System have small proper motions, our survey was optimized to detect slowly moving objects (SMOs). The angular motions of SMOs are sufficiently small that little trail-losing loss results from sidereal tracking. This strategy is found to provide optimum sensitivity to the linear, correlated motion expected of slowly moving objects. By restricting observations to stellar images of full width at half maximum (FWHM) < 1.0 arcsec, and to moonless skies, we obtain limiting magnitudes $m_R < 25$. To date, a
TABLE 1 Preliminary orbital parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-major axis a</td>
<td>44.4 au</td>
</tr>
<tr>
<td>Eccentricity e</td>
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<tr>
<td>Inclination i</td>
<td>22°</td>
</tr>
<tr>
<td>Orbital period P</td>
<td>296 years</td>
</tr>
<tr>
<td>Perihelion date T</td>
<td>1992 AD 2023</td>
</tr>
<tr>
<td>Perihelion distance q</td>
<td>38.6 au</td>
</tr>
<tr>
<td>Aphelion distance Q</td>
<td>49.1 au</td>
</tr>
</tbody>
</table>

Based on astrometry in the interval 1992 August 30 to December 25. The orbit solution is by Marsden. We measured on UT 1992 August 30 and September 01. Our best estimates are $m_V - m_B = 0.6 \pm 0.1$ and $m_V - m_I = 1.0 \pm 0.2$, to be compared with solar colours $m_V - m_R = 0.32$ and $m_V - m_I = 0.4$, respectively. Here $m_V$, $m_R$, and $m_I$ are the stellar magnitudes measured with V (5,500 Å), R (6,500 Å) and I (8,000 Å) filters. The $m_R - m_I$ colour is based on a single I filter image. Nevertheless, it seems that 1992 QB$_1$ is substantially redder than sunlight, inconsistent with a surface of pure ice but consistent with dirty ice, or one contaminated with organic compounds. For comparison, the corresponding colours of the distant object 5145 Pholus are $m_V - m_R = 0.7$ and $m_R - m_I = 0.7$ (ref. 15), and all other known cometary nuclei are substantially less red. Both Pholus and 1992 QB$_1$ may retain primitive organic mantles produced by prolonged cosmic-ray irradiation. Such mantles would be disrupted or buried by rubble mantles on active, near-Sun comet 15.16. Figure 2 shows the surface brightness profile measured from images taken UT 1992 September 01. The profile of a nearby field star is shown for comparison. Figure 2 supplies no evidence for a resolved coma down to surface brightness 29 mag per square arcsec, at a distance of 1.5 arcsec from the centre of the image. The absence of resolved coma allows us to place a model-dependent limit on the mass loss rate from 1992 QB$_1$, using a profile-fitting method. This limit is $dm/dt < 0.7 kg s^{-1}$, so 1992 QB$_1$ is at least 10 times less active than a Halley-class, near-Sun comet and probably less active than 2060 Chiron ($dm/dt = 1 kg s^{-1}$). Weaker activity cannot be constrained by existing observations, however.

![Figure 1](https://example.com/figure1.png)

**FIG. 1** Discovery images of 1992 QB$_1$ (marked by arrows), obtained UT 1992 August 30 at the University of Hawaii 2.2-m telescope, using a Mould R filter (central wavelength $\lambda = 6.500 \mu m$, FWHM $\Delta \lambda = 1.250 \mu m$). The images show regions of a $2.048 \times 2.048$ pixel Tektronix CCD (each pixel subtends 0.22 arcsec). Stelar images are about 0.8 arcsec FWHM. The elongated object to the lower right in the top image is a main-belt asteroid; it appears in the top left of the bottom image and demonstrates the extraordinarily slow motion of 1992 QB$_1$. The field shown is ~90 arcsec in width.

![Figure 2](https://example.com/figure2.png)

**FIG. 2** Surface brightness profile of 1992 QB$_1$ measured UT 1992 September 01 with 0.8 arcsec FWHM images. The profile was computed from four separate R-filter images of total integration time 3,600 s. A scaled profile of a nearby field star is shown for reference. The image of 1992 QB$_1$ is consistent with a point source down to surface brightness $-29$ magnitudes per square arcsec.

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Dust particle impacts during the Giotto encounter with comet Grigg-Skjellerup


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In the European Space Agency's 1992 Giotto Extended Mission, the Dust Impact Detection System operated successfully during a fly-by that took the spacecraft within about 200 km of the nucleus of comet Grigg-Skjellerup. During the encounter, three meteoroid impacts were detected on Giotto's front shield. The particle masses were found to be $100\mu g$, $2\mu g$ and $20\mu g$, suggesting that the mass distribution of the cometary dust was dominated by larger particles. This is supported by the independent detection of a very large meteoroid ($14\mu m$) by the astrometric observations, and is consistent with data over the same mass range from the 1986 encounter with comet Halley. The results indicate a higher rate of mass loss from the nucleus than previously thought, and hence a higher dust-to-gas mass ratio.

The Dust Impact Detection System (DIDSY) was designed to measure the flux of dust particles in the mass range $10^{-19}$ kg to $>10^{-6}$ kg in the coma of comet Halley (Fig. 1, refs 1 and 2). The DIDI IMP-P sensor suffered impact damage at the Halley encounter, and at Grigg-Skjellerup, the instrument was noisy and gave no interpretable results. The DIDI IMP-M sensor, however, was fully operational. The DID7 CIS sensor also suffered impact degradation at Halley, and was largely non-operational. The piezoelectric momentum sensors (DID2 to 5) were fully operational.

The 1986 Halley encounter geometry was such that particles struck the front shield at normal incidence with relative velocity $68.5\pm1.9$ km s$^{-1}$. A hypervelocity particle having momentum $m_0$ will transfer momentum $m_0 v$ to the shield (the enhancement factor is due to target eja) where $v$ is the momentum enhancement factor. The value taken at Halley was $v=11$. At Grigg-Skjellerup the trajectories of particles striking the shield made a $21.2^\circ$ angle with the shield at a relative velocity of $13.8$ km s$^{-1}$. These factors reduced $v$ considerably. Experiments using the 2-MV dust accelerator at the Unit for Space Sciences, Kent, yield a value of $v=3.1\pm1.0$. This reduced value of $v$ raises the piezoelectric