**Absolute Magnitudes of Supernovae[[1]](#footnote-1)**

Using the light curves of nine Type Ia supernovae that appear in galaxies during the years 1994-1996, determine the absolute magnitude of a Type Ia supernova explosion. Each supernova was monitored for several weeks so that its rise to maximum light and its subsequent decline in brightness are well-determined. For each, the apparent magnitude at which the supernova was brightest can be determined from the light curve.

The distances to the galaxies have been determined using the Hubble Law and the speeds of recession of the galaxies. The recession velocities of the host galaxy of each supernova were measured from the redshift of spectral lines. The recession velocity must be measured from the host galaxy, rather than from the supernova itself, because the gas from which the supernova spectrum arises is expanding explosively from the original supernova progenitor.

Record the brightest apparent magnitude reached for two of the supernova in the table below. Also enter the distance modulus of the galaxy using the graph on the next page to determine the distance modulus. (For those of you more mathematically inclined, the distance modulus can be calculated from the expression Distance Modulus = 5 log10(distance in parsecs) – 5.

Finally, calculate the absolute magnitudes of the supernovae - Recall that

Distance Modulus = apparent – absolute magnitude.

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| --- | --- | --- | --- | --- | --- | --- |
| Supernova | Host Galaxy | Recession velocity (km s-1) | Distance in Mpc for Ho=72 km s-1 Mpc-1 | Distance Modulus | App Mag (mmax) | Absolute Magnitude (M) |
| 1994S | NGC 4495 | 4,463 | 62 Mpc |  | 14.8 |  |
| 1995D | NGC 2962 | 1,998 | 28 Mpc |  |  |  |
| 1994ae | NGC 3370 | 1,279 | 18 Mpc |  |  |  |
| 1995al | NGC 3021 | 1,536 | 21 Mpc |  |  |  |
| 1995ac | Anon | 14,615 | 203 Mpc |  |  |  |
| 1995bd | UGC 3151 | 4,758 | 66 Mpc |  |  |  |
| 1996X | NGC 5061 | 2,034 | 28 Mpc |  |  |  |
| 1996bl | Anon | 10,598 | 148 Mpc |  |  |  |
| 1996bo | NGC 673 | 5,063 | 70 Mpc |  |  |  |

The absolute magnitudes of the supernovae should be negative, since the supernovae are very bright compared to ordinary stars (smaller magnitudes are brighter!). Each 5 magnitudes is a factor of 100 in brightness.

What is the median absolute magnitude of this set of Type Ia supernovae?

How does the brightness of a Type Ia supernova vary with distance? Would Type Ia supernovae be useful as “standard candles” to determine distances to galaxies?

What is peculiar about the supernova 1995bd? What explanation might account for its difference from other Type Ia supernovae?

1. *This exercise is based on one developed by Lindsay Clark (see* [*http://www.astro.princeton.edu/~clark/SNLab.html*](http://www.astro.princeton.edu/~clark/SNLab.html)*), and has been adapted for our use.* [↑](#footnote-ref-1)