Calibrating a Standard Candle for Extragalactic Distance Measurements

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Astronomical Measurements and Units

- $B$ = astronomical apparent magnitude
- $L_B$ = relative luminosity (rel. to $B_{sun}$)
- $B_D = 10^{-0.4(B_d - B)}$
- $B_D = 2.5 log_{10} [B_d]$
- $M_B$ = astronomical absolute magnitude
- $\mu = B - M_B$ = distance modulus
- $\mu = 5 \log D + 25$ ($D$ = distance [Mpc])

Light Curve Data and Fits

- Fitted Magnitudes
- Obs. B magnitudes
- $\Delta t_{max}$

Components of the Luminosity

- $L(t) = W(t, \alpha, \beta, \gamma)$
- $W(t) = W(t, \alpha, \beta, \gamma)$
- $\Delta t_{max}$

Distance Calibration

- To estimate distance to a faraway supernova:
  1. Measure for light curve (more than 150 days)
  2. Use the model to determine $\alpha$, $\beta$, and $M_B$
  3. $M_B = -25 + 5 \log D$
  4. $D = \frac{1}{5 \log D + 25}$

Radioactive Decay Model for Light Curve

- $W(t, \alpha, \beta, \gamma) = \exp \left( \frac{t}{\mu} \right)$
- $\Delta t_{max}$
- $\alpha$ = shape parameter
- $\beta$ = scale parameter

Light Curve Data and Fits

- Snapshots of the luminosity of a recent supernova, indicated by the green arrow.
- The luminosity appears suddenly, peaks, and then fades over a period of months.