

Physical Sciences 120
Winter 2005

*Origin of the Universe,
and How We Know*

Don Q. Lamb

Lecture 23

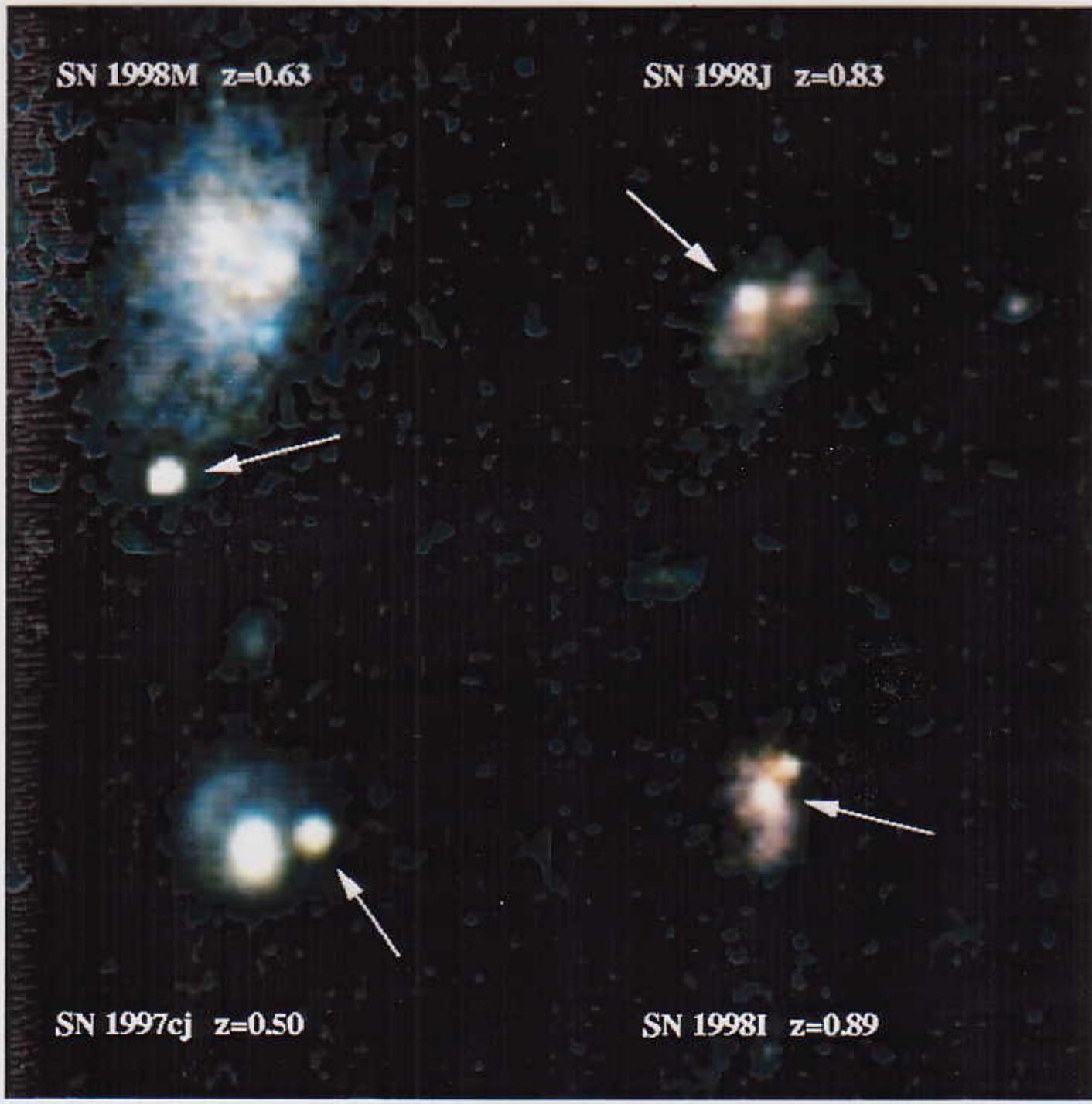
**THE ACCELERATING
UNIVERSE**

SN 1998M $z=0.63$

SN 1998J $z=0.83$

SN 1997cj $z=0.50$

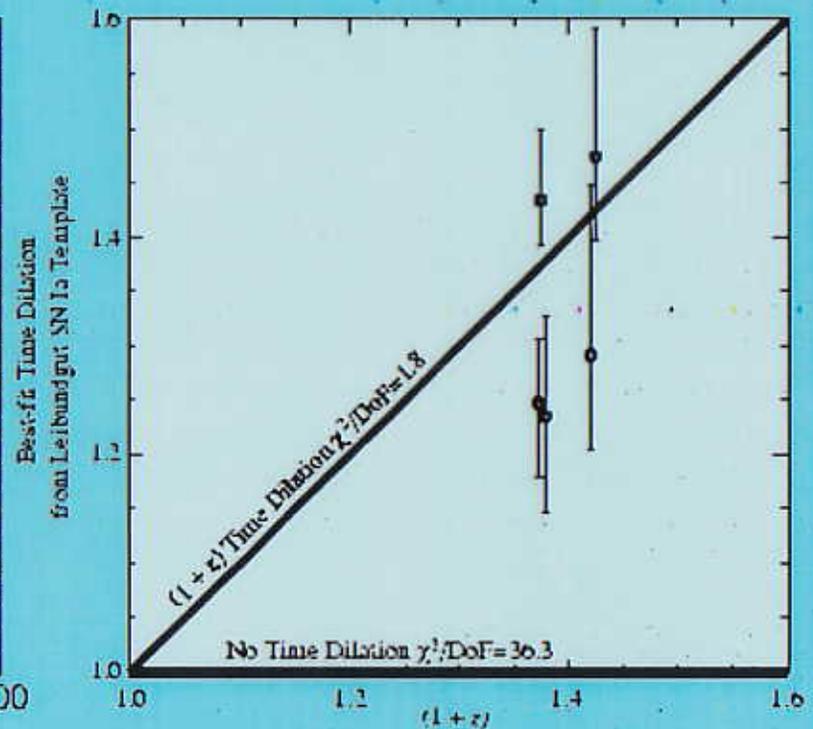
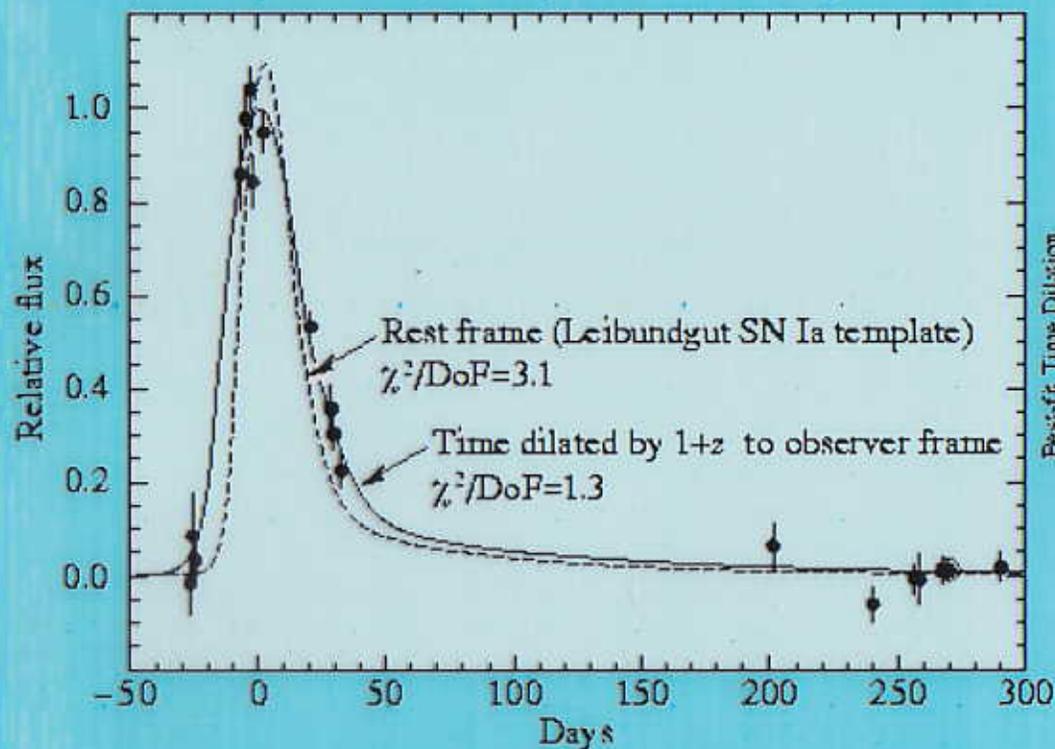
SN 1998I $z=0.89$



Test of Cosmological Expansion

G. Goldhaber et al. (1996)

Despite small variations in their light-curve shapes, Type Ia's can be used as standard clocks to test the hypothesis of cosmological expansion. In an expanding universe, clocks at redshift z will run slow by a factor $1+z$. Thus we expect our SN light curves to be broader than those observed locally. We calculate the best fit dilation factor for each supernova and get the following results.



C. Pennypacker

M. DellaValle
Univ. of Padova

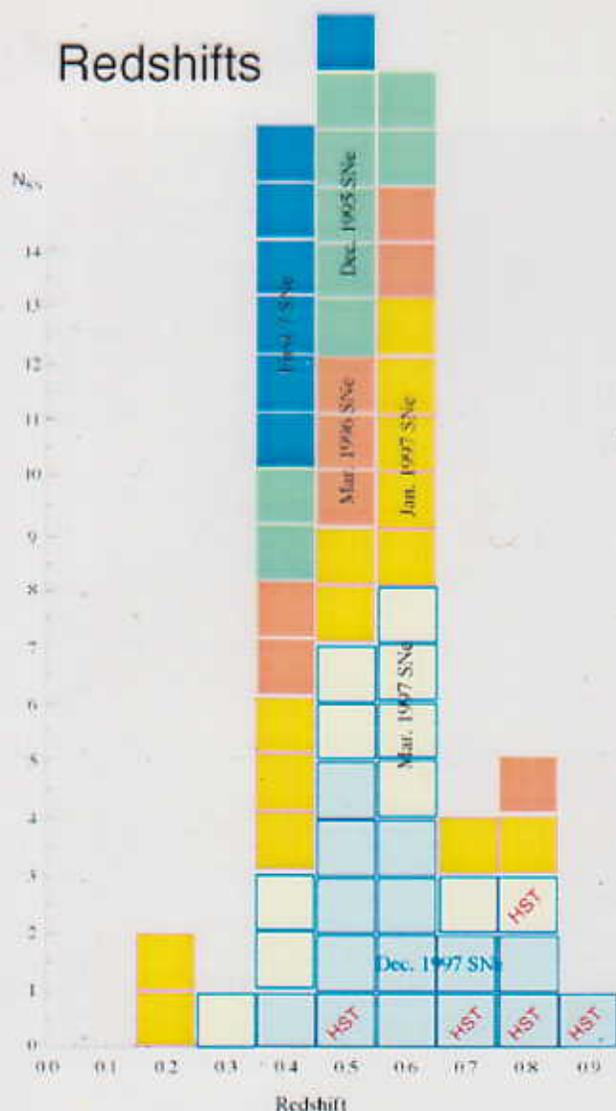
B. Ellis, R. McMahon
IoA, Cambridge

B. Schaefer
Yale University

P. Ruiz-Lapuente
Univ. of Barcelona

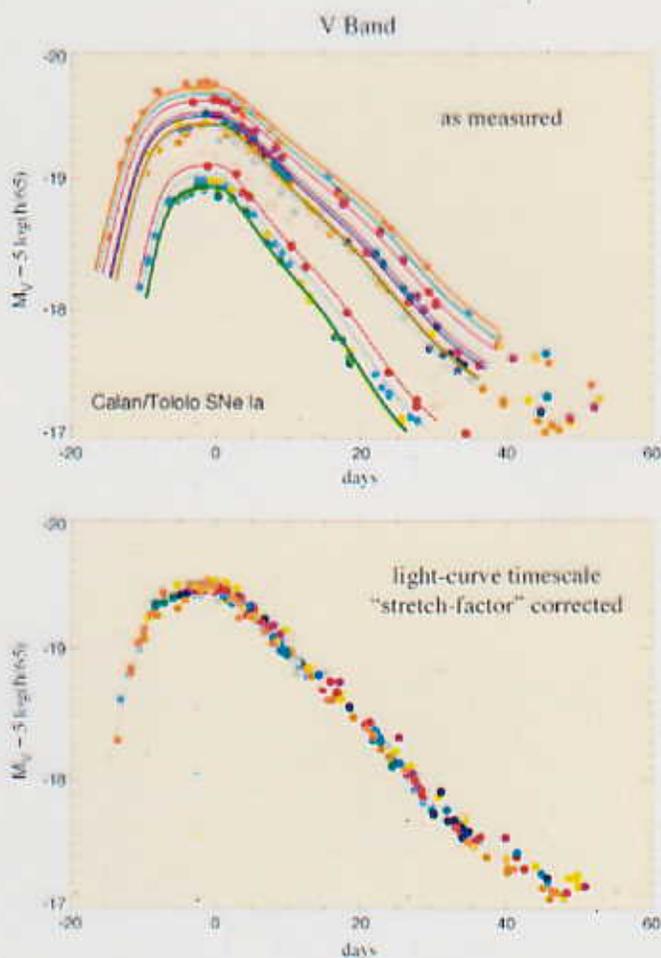
H. Newberg
Fermilab

Redshifts



We have discovered well over 50 high redshift Type Ia supernovae so far. Of these, approximately 50 have been followed with spectroscopy and photometry over two months of the light curve. The redshifts shown in this histogram are color coded to show the increasing depth of the search with each new "batch" of supernova discoveries. The most recent supernovae, discovered the last week of 1997, are now being followed over their lightcurves with ground-based and (for those labeled "HST") with the Hubble Space Telescope.

Low Redshift Type Ia Template Lightcurves



Type Ia supernovae observed "nearby" show a relationship between their peak absolute luminosity and the timescale of their light curve: the brighter (superovae) are slower and the fainter supernovae are faster (see Phillips, Ap.J., 1993 and Riess, Press, & Jayaram, Ap.J., 1995). We have found that a simple linear relation between the absolute magnitude and a "stretch factor" multiplying the lightcurve timescale fits the data quite well until over 45 restframe days past peak. The lower plot shows the "nearby" supernovae from the upper plot, after fitting and removing the stretch factor, and "correcting" peak magnitude with this simple calibration relation.

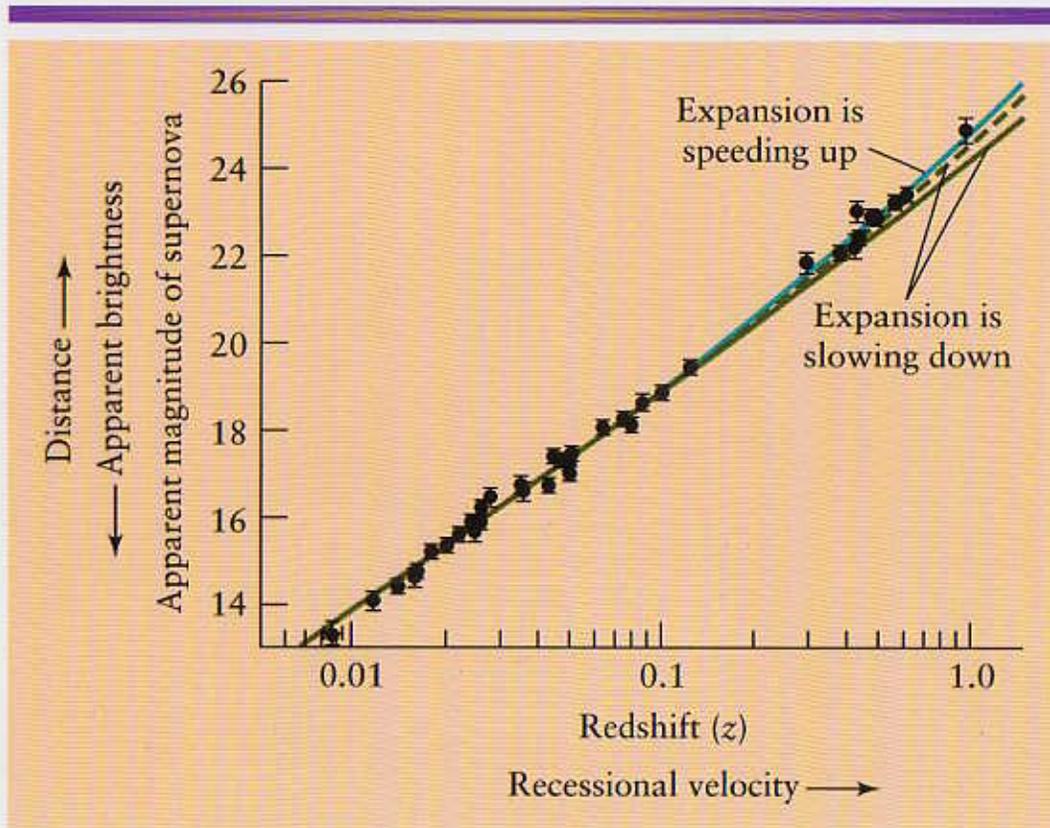
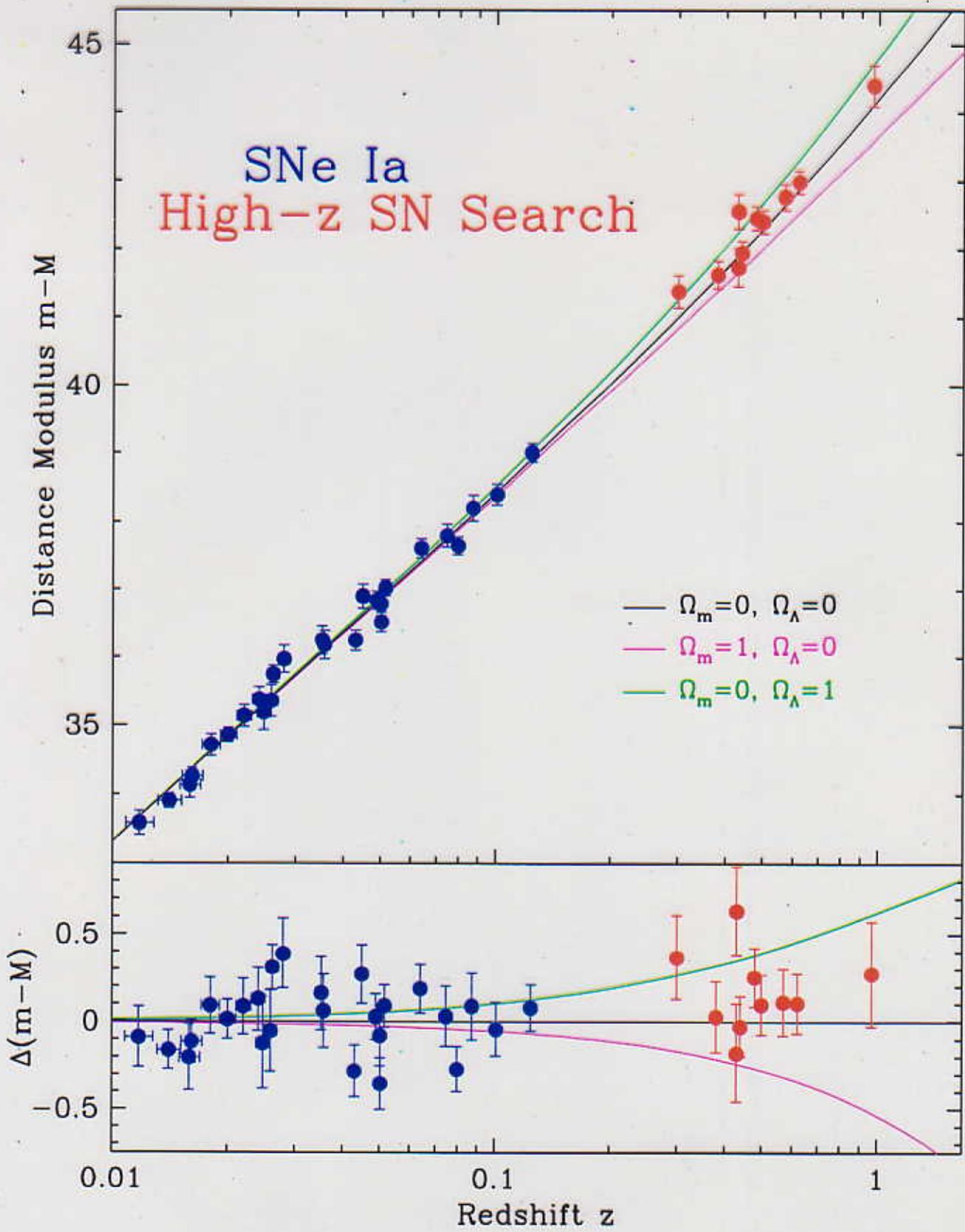
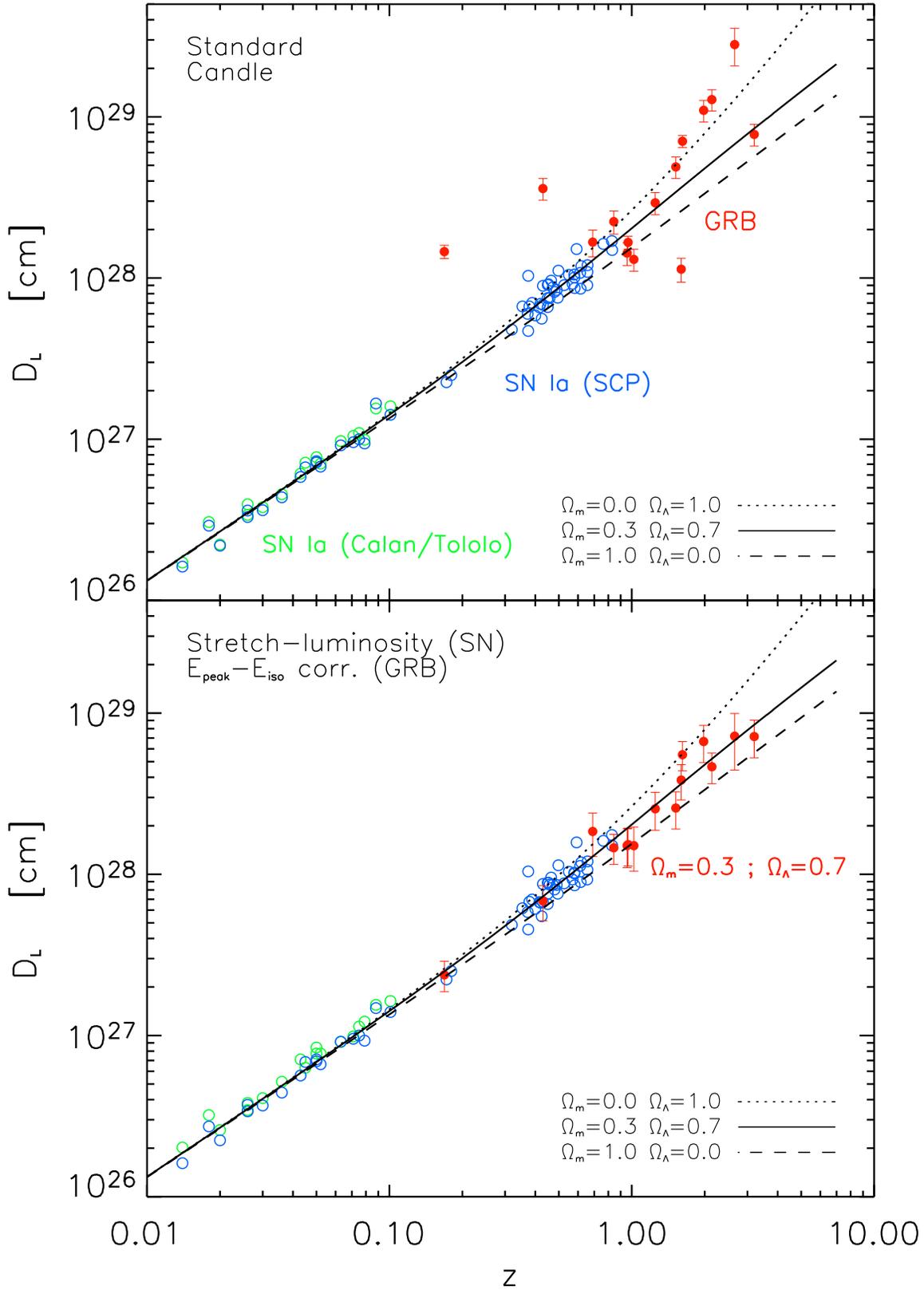


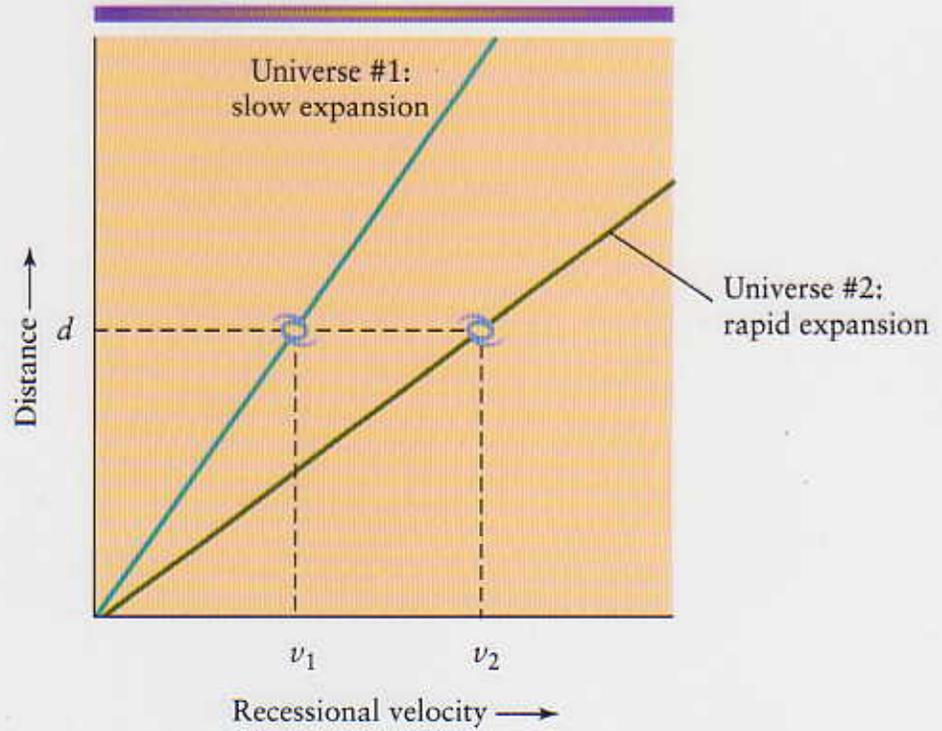
Figure 28-18

Roger A. Freedman and William J. Kaufmann III. UNIVERSE, Sixth edition. Copyright © 2002 by W. H. Freeman and Company.

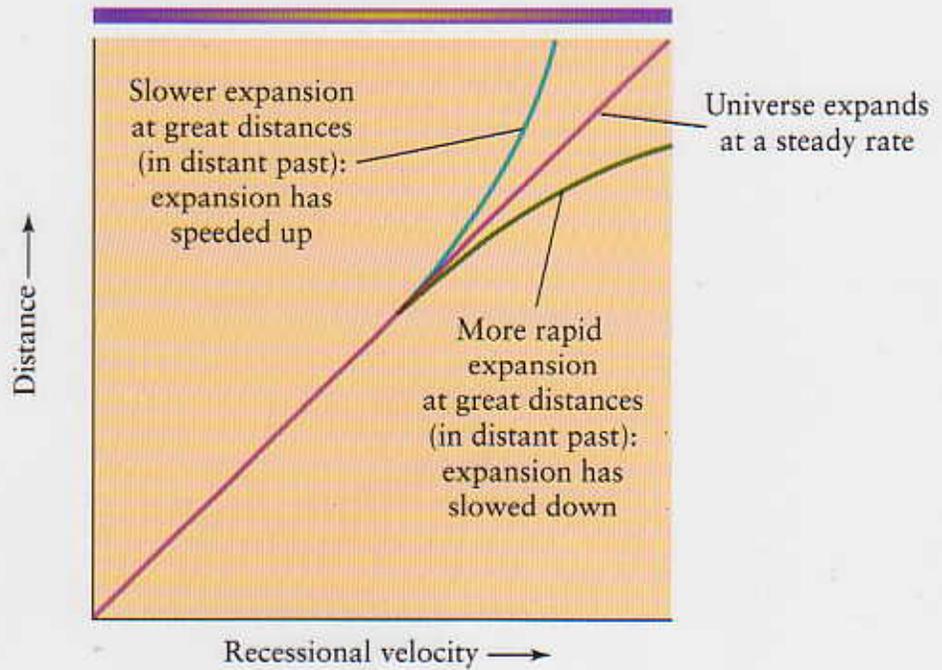
SNe Ia
High-z SN Search







a



b

Figure 28-17

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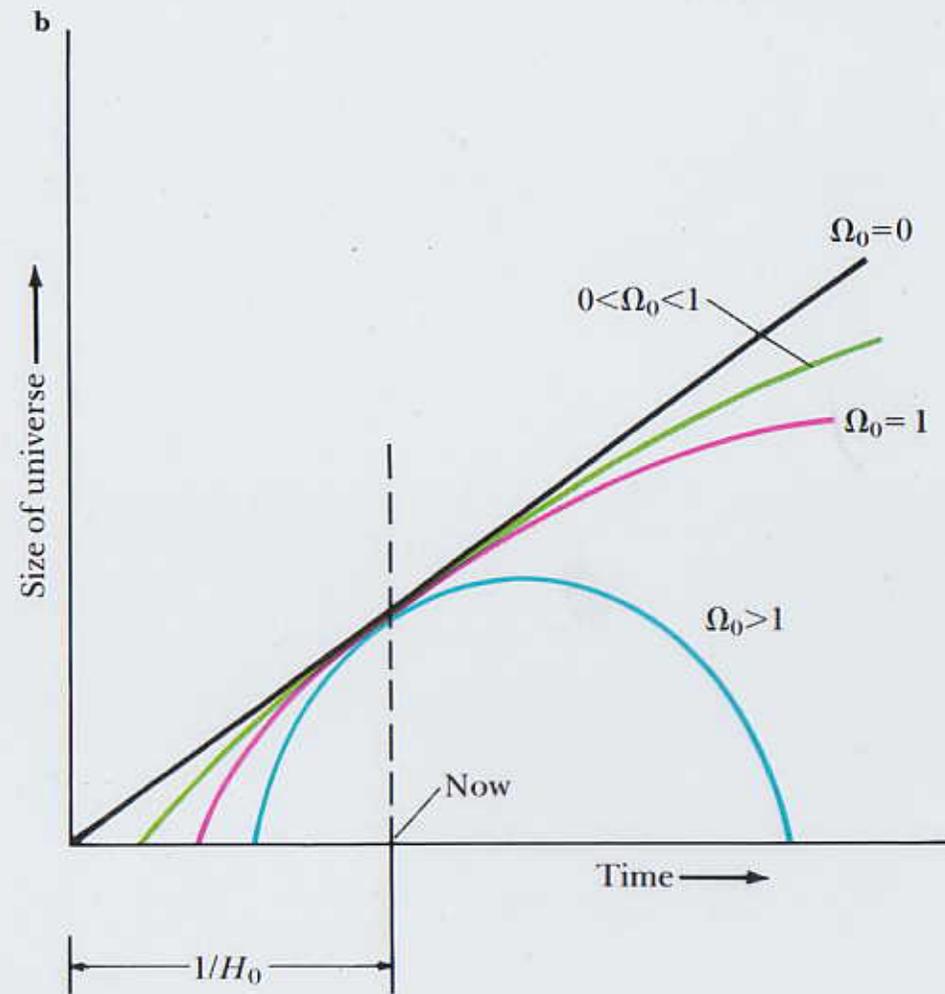
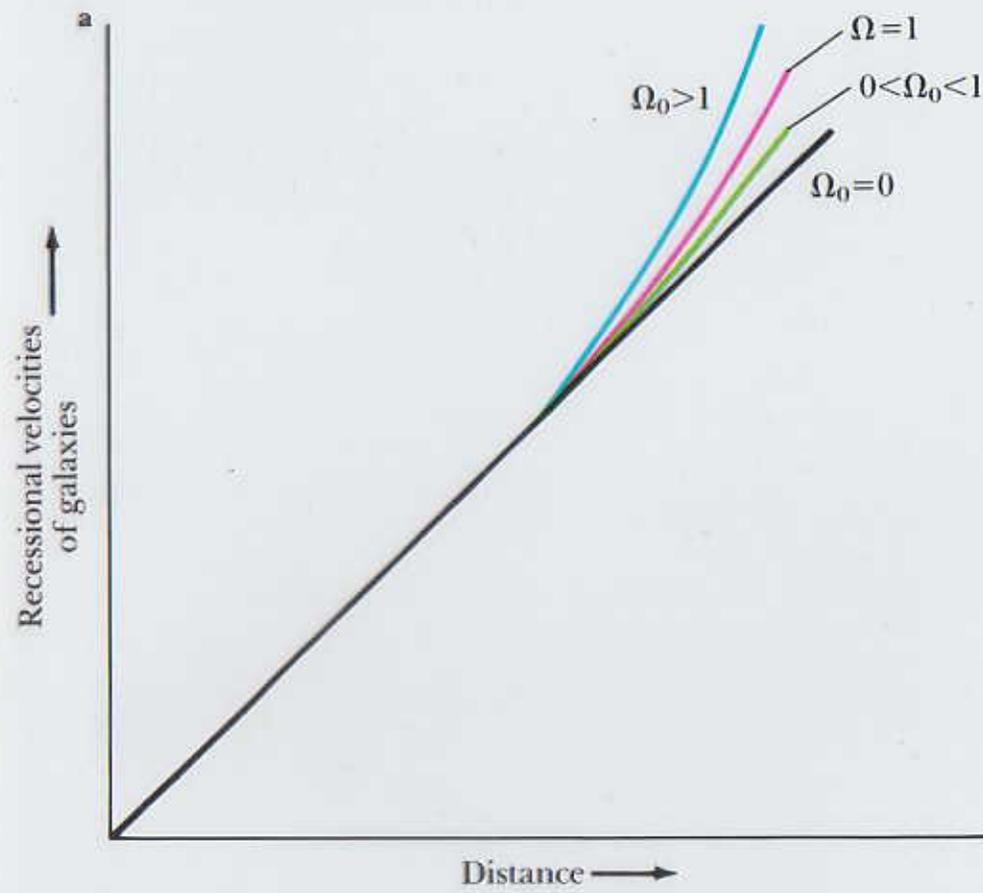


Figure 19-7
Kaufmann
DISCOVERING THE UNIVERSE
Second Edition
 © 1990, W. H. Freeman and Company

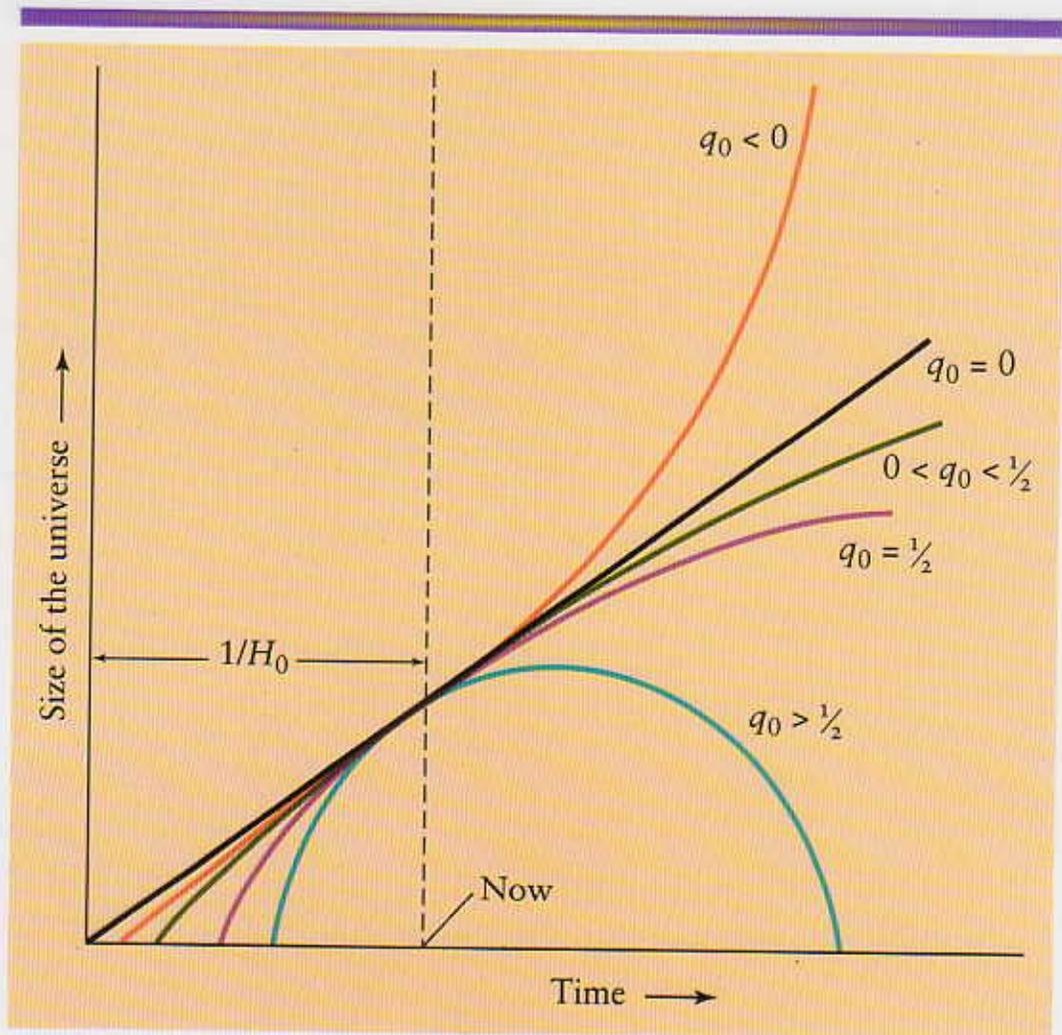


Figure 28-21

Roger A. Freedman and William J. Kaufmann III. UNIVERSE, Sixth edition.
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Expansion History of the Universe

Perlmutter, Physics Today (2003)

