[Absolute Magnitudes of Supernovae – Charles T. Kowal (1968) 2](#_Toc180849861)

[Search for Supernovae – Fritz Zwicky (1959) 3](#_Toc180849862)

[Problems in the determination of the distances of galaxies – W. Baade (May 1958) 4](#_Toc180849863)

[Photographic light-curves of the two supernovae in IC 4182 and NGC 1003\* - W. Baade and F. Zwicky (November 1939) 5](#_Toc180849864)

[The absolute photographic magnitude of supernovae – W. Baade (Oktober 1938) 6](#_Toc180849865)

[Summary 7](#_Toc180849866)

Absolute Magnitudes of Supernovae – Charles T. Kowal (1968)

In the past: attempts to get average absolute magnitude were unsuccessful, because there were hardly any complete light curves. They had to do projected calculations to get full light curves.

Now: 40 curves for supernovae available 🡪 Maxima magnitudes are pretty dependable   
magnitudes corrected for galactical absorption, radial velocities for solar motion  
no correction for absorption in parent cloud 🡪 average magnitudes are lower limits

To get the absolute magnitude: estimate distances with different methods, based on an assumed Hubble constant (e.g. luminosity classification of galaxies)

Magnitudes of Supernovae Type 1. Hope to be a trustworthy indicator of distance

Distance supernovae will need a correction for the red shifting of the emission bands (no correction in this study)

For type 1: 22 light curves, for 19 of them distance moduli

For type 2: 9 light curves with differences in form,

For Type 4: 1 known supernova

For Type 5: 1 studied supernova, the absolute magnitude with luminosity classification and membership in group

Future: The uncertainty of the redshift-magnitude relation can get less with the discovery of more supernovae at a distance comparable to the Coma cluster. Determine the second-order term for the relation once light curves for supernovae far away are obtained.

Problem for distance indication now:   
Hubble constant cannot be determined with Supernovae alone, because the absolute magnitudes of closer supernovae cannot be calculated because the distance moduli are unreliable.

Search for supernovae in different galaxies: happening at Palomar observatory

Several sources for the magnitudes

Search for Supernovae – Fritz Zwicky (1959)

Studies of supernovae important for: evolution of stars and stellar systems, nature of neutron stars, origin of cosmic rays

Calibration of distances with supernovae: here mentioned as a possibility

Original SN search: 1933 at Caltech (ended because of war and amount of work)  
1956 renewed at several observatories (worked together) 🡪 new supernovae were found

Prove that supernovae exist: observations made in 1937 at Palomar Observatory (Schmidt telescope)

Schmidt telescope was built to search SN 🡪 discovery of more SN

Analyzing the light curves led to the conclusion that there are several SN types

Hope for the future: photograph two recently discovered SN in later stages of development in different colors 🡪 get physical characteristics about their ends of the light curve 🡪 establish the use of SN as distance indicators

Problems in the determination of the distances of galaxies – W. Baade (May 1958)

Distance of galaxies based on objects within them. How to get distance: apparent magnitude, applying inverse square law, in consideration of interstellar absorption

Measuring of apparent magnitude: photometry

Determination of apparent magnitudes was made difficult because of several different sequences (photographic sequences in selected areas)  
E.g.: Polar sequence (= series of stars near the north celestial pole, accurate magnitudes, standard for magnitudes)

Requirements for distance indicators in galaxies: well-defined luminosity, easy to observe 🡪 most distance indicators are still variable stars in order to fit the requirements

Two populations of distance indicators in extragalactic systems. Novae belong to population 2

Work from before: had too long breaks between observations to determine the maximum luminosities. Now: new work on cross connections (Arp)

Arp finds two groups of luminosities: fast novae and slow novae

Photographic light-curves of the two supernovae in IC 4182 and NGC 1003\* - W. Baade and F. Zwicky (November 1939)

Before: systematic search would be necessary to advance further in the field 🡪 effort for this very big and needs to be justified (with a proper instrument)

Such a telescope (Schmidt telescope) was built at the Palomar Observatory 🡪 systematic search now possible

IC 4182 and NGC 1003: were bright 🡪 allowed for photometric and spectroscopic observations/measurements over a long period of time

Bigger sequences of comparison were needed (different instruments were used to measure different ranges of photographic magnitudes of the comparison stars) Used: Palomar and Mount Wilson instruments  
magnitudes of comparison stars: on the international system (candela unit?)

NGC 1003: low latitude 🡪 values not corrected for general galactic absorption 🡪 should be multiplied with: log f = -0.05 |cosec b| (according to Hubble)

The absolute photographic magnitude of supernovae – W. Baade (Oktober 1938)

Distances: were possible to measure as soon as reliable values for the luminosities of novae in the milky way were existing

But problem: luminosities of extragalactic novae spread wide (good example to look at is Andromeda nebula)

Possible reasons for spread of luminosities: large dispersion in absolute magnitudes, two different groups of novae

Hubble confirmed second reasoning a few years later

Spectroscopic investigations showed a strange spectrum (wide and in some areas overlapping emission bands) which supported the existence of two groups  
if spectrum is known: can sort the novae into the group it belongs

Two groups: common type and supernova

Results used in this report: only approximations as the systematic search will later bring better data, some of the data from casual discoveries  
sometimes: objects were actually plate defects or ordinary variable stars.

Baade redetermined magnitudes of the comparison stars with polar comparison to receive reliable photometric data (proved to be a good idea)

Maximum only really known for 4-5 supernovae, the rest of the data mostly belongs to the descending branch of the light curve.

IC 4182 and NGC 1003 light curves were combined, combination was used as the standard

List of 14 supernovae

10 supernovae with known maximum magnitude and distance modulus   
proper spread of dispersion of maximum absolute magnitude will be smaller than the calculated value (calculated value includes errors in maximum apparent magnitude and distance modulus)

Use the distance modulus of those 10 to calculate the absolute magnitudes of the nebula they appeared in

Only two groups of novae, nothing in between them (believed because of their well defined statistic separation)

Nova B Cassiopeiae and crab nebula: in our milky way, thought to have been supernovae 🡪 might help to solve question about final state of supernova

Method needed for further search: spectroscopic survey (extends investigation to fainter limits)   
Planned to be done as soon as an efficient slitless spectrograph for the Newtonian focus for the reflectors is available

Summary

(points written in point of view of the time of the articles)

Often mentioned observatories: Bergedorf, Palomar, Mount Wilson, Heidelberg, Hamburg, Harvard

Often mentioned names: W. Baade, van den Bergh, Minkowski, Zwicky

First ideas: late 1930s. data was often only estimates and only little data was available. Luminosity values were not reliable   
improvement with Schmidt telescope, which could do systematic searches   
not really any complete light curves, maximum magnitudes also mostly unknown   
splitting into two groups: common novae and super novae   
existence of supernovae was proved (1937)  
(🡪 not really the possibility yet to measure or calculate distances but mentioned to maybe be possible at some point)

Late 1050s: indication of distance depended on objects within that galaxy, their apparent magnitude was needed (sometimes hard to determine because of different photographic sequences), with inverse square law the distance could be calculated, interstellar absorption was considered   
problem: distance indicators often still variable stars   
Two group of luminosities: fast and slow  
light curves lead to conclusion that several types of SN exist

Late 1960s and onward: more complete light curves, reliable values for magnitudes 🡪 distance can be indicated/calculated   
Several more discovered SN, more data available for those  
problem: Hubble constant cannot be defined with SN alone, distant moduli for near SN not reliable   
Future: distant SN will need a correction for red-shift magnitude relation