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September 17, 2020

Title: On the Physical Condition of the Supernovae
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Communicated May 14, 1936 in Proc N.A.S.

One of the forefront issues in early 20th century astrophysics was on the nature of the deaths of stars. One of the possible fates of a star is to nova, where a star undergoes runaway fusion causing an ejection of the stellar atmosphere. The ejecta form an envelope of light sometimes visible to the naked eye, giving the appearance of a"new" (hence the Latin *nova*) star. Information about novae are derived from spectra and light curves which yield essential data about composition, radial velocities, luminosity, and temperature.

Evidence for a larger scale cataclysmic event, the so-called "supernova", was gathered by Walter Baade and Fritz Zwicky in 1934. The prevailing wisdom of Baade and Zwicky maintained that the conditions that produce these events were fundamentally different from normal galactic novae. At the time of these arguments the spectra of supernovae were not well studied, leaving key information out of the deductions of their statements.

In 1936, Harvard astronomer Cecelia Payne Gaposchkin, armed with spectroscopic information of supernovae S Andromedae and Z Centauri, argues that Baade and Zwicky were wrong about the nature of the conditions for supernovae. Payne Gaposchkin cites that the spectra of S Andromedae and Z Centauri differ from the spectra of normal galactic novae only in the radial velocity of the ejecta. Payne Gaposchkin cites two other recent supernovae with spectral observations consistent with those of S Andromedae, NGC 4273 and NGC 4303. Noting that for ordinary nova of the same spectral type have an upper bound on temperature of $\sim 50000°$, Payne Gaposchkin shows that the maximal temperature of these three supernovae are well withing this upper bound. This rules out the excessively high temperatures postulated by Baade and Zwicky, and indicates that supernovae differ from ordinary galactic novae only in luminosity and expansion velocity.

Payne Gaposchkin continues to show that the difference in temperatures of her calculations and those of Baade and Zwicky are entirely due to a different assumption of maximal supernova radii. Contrary to intuition, Baade and Zwicky argued that the maximal radii of supernovae were smaller than those of normal galactic novae. Payne Gaposchkin retorts by showing that the maximal radii are in fact governed by the mass, radial velocity, and energy, pointing towards supernovae having greater maximal radii.

The final argument of Payne Gaposchkin in disagreement with Baade and Zwicky regarded the amount of energy radiated in a supernova event. The original conclusion of Baade and Zwicky claimed that the mass of the radiation was of the order of the original mass of the star, which Payne Gaposchkin argues is overly sensitive to the assumed surface temperature. In her calculations, Payne Gaposchkin shows that the mass radiated in a supernova is several orders of magnitude smaller than the mass of the progenitor star.

In only five pages of text, Cecelia Payne Gaposchkin completely flipped the academic understanding of the nature of supernovae. Her pivotal 1936 paper completely exposed the flaws of all prevailing views about the conditions that cause supernovae, particularly those of Walter Baade and Fritz Zwicky. Payne Gaposchkin posited that supernovae were not as enigmatic and different from normal galactic novae as Baade and Zwicky suggested, offering the insight that they are in essence only different in scale, a statement that remains prevalent over 80 years later.