50 & 100 YEARS AGO

NATURE

50 YEARS AGO

Women who have had a university education want to use their capacities to the full and to make a contribution to society. How can they combine this with marriage and motherhood? Mrs. Judith Hubback, herself a graduate mother, tried to find this out by sending out, in 1953, a questionnaire to 2,000 married women graduates ... It is found that the marriage rate for women graduates is almost up to the normal, that they tend to be more fertile than average, that it takes some fifteen years before the last child is at school, that circumstances during the period of raising children give little opportunity for systematic intellectual pursuits or for an outside career, but that part-time teaching is the career most easily combined with family life ... A whole chapter is devoted to overtiredness, due to diffuse, routine domestic work, which leads to frustration, and it is found that work outside the home, even part-time, results in a freshness of outlook and not in extra fatigue. In the discussion, the need is stressed for a sane compromise between the biological aspects of a woman's life, as a mother carrying on the race, and the intellectual side developed by a university education.

From *Nature* 15 February 1958.

100 YEARS AGO

Prof. Dunbar, as the result of a series of experiments conducted over a long period and with every care, has come to the conclusion that the bacteria are not an independent group of organisms, but, together with some of the yeasts and moulds, are stages in the life-history of green algae ... A pure culture of a single-celled alga belonging to the Palmellacia was obtained, but by modifying the culture medium by the addition of acid, alkali, or traces of copper salts, other organisms, generally bacteria, occasionally moulds and yeasts, and even spirochaetes, made their appearance in the pure cultures.

From *Nature* 13 February 1908.

conclude that type Ia supernovae are explosions of 'electron-degenerate' stars consisting of carbon and oxygen. In these 'dead' stars, known as CO white dwarfs[5], the outward pressures caused by the processes of nuclear fusion at some point ceased to provide a counterbalance to the star's own gravity. The star's matter collapsed down so far that all its electrons sought to squeeze into their lowest energy state (to become 'degenerate'). At this point, the Pauli exclusion principle — which states bluntly that this can't happen — put a brake on the gravitational collapse.

If, however, the mass of a white dwarf increases above a certain limit — the Chandrasekhar limit, about 1.39 times the mass of the Sun — the degeneracy pressure created by the exclusion principle cannot prevent further collapse. The resulting rapid increase in density and temperature causes the runaway fusion of carbon and oxygen nuclei to heavier elements, ending mainly in iron. The sudden and enormous energy release of this chain reaction blows up the whole star.

These thermonuclear supernovae are very different from their cousins, the core-collapse supernovae. Core-collapse supernovae have very massive progenitors, at least 8 times the mass of the Sun, and leave behind neutron stars or black holes. The CO white dwarfs, by contrast, are the remnants of the burnt-out cores of stars that started out with masses below 8 solar masses. These white dwarfs are typically similar in size to Earth but, owing to their high density, their masses are several hundred thousand times larger, between 0.6 and 1.2 times that of the Sun. For a white dwarf to grow to the Chandrasekhar limit, therefore, it must gain matter from somewhere. The most easily conceivable way in which it might do this is by the transfer of mass from a companion star in a binary system.

In the single-degenerate model[6] (Fig. 1), the companion of the white dwarf is a normal, non-degenerate, hydrogen-rich star. If the rate of mass transfer to the white dwarf exceeds 10^{-7} solar masses per year, the deposited layer of hydrogen ignites in steady fusion, and the white dwarf will gradually grow in mass. (At smaller transfer rates, the hydrogen on the white dwarf ignites explosively and the white dwarf is unlikely to grow.) White dwarfs experiencing steady fusion are known as luminous super-soft binary X-ray sources[7], and were first discovered[8] in another galaxy in 1990, and later also in our own Galaxy.

The single-degenerate model has a competitor: the double-degenerate model. In this scheme, two white dwarfs with a combined total mass above the Chandrasekhar limit merge as their orbits shrink through the stars' emission of gravitational waves. For such a system to merge on a timescale shorter than the age of the Universe, it must have been born with an orbital period of less than about 12 hours. In recent years, such close double-white-dwarf systems have been discovered in our Galaxy,

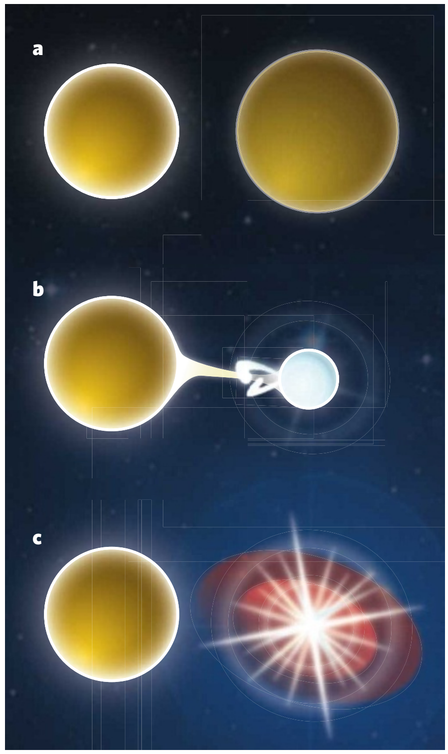

Figure 1 | A degenerate's progress. a, In the beginning of the single-degenerate model of how type Ia supernovae arise, two stars of moderate size coexist peacefully in a binary system. The nuclear fuel of the more massive one, which evolves faster, eventually becomes exhausted, causing it to collapse in on itself and become a white dwarf — a core of very dense 'electron-degenerate' matter, mainly in the form of carbon and oxygen. **b**, Through the transfer of mass from the normal star, the mass of the white dwarf increases past the Chandrasekhar limit of 1.39 times the mass of the Sun, and the white dwarf collapses further. **c**, The rapid increase in temperature and density during this collapse triggers the runaway nuclear fusion of carbon and oxygen to (principally) iron, causing the star to blow up in a type Ia supernova explosion, probably leaving no remnant.

although none as yet has the requisite total system mass to exceed the Chandrasekhar limit. Double white dwarfs are so faint that, with current observational capabilities, they cannot be discovered in other galaxies. The luminous super-soft binary systems, by contrast, whose energy output in X-rays alone is typically more than 10,000 times the total energy output of the Sun, are bright enough to be seen at X-ray wavelengths out to distances of several tens of millions of light years.

Voss and Nelemans's discovery[1] of just such a soft X-ray progenitor where a supernova has now been seen is a breakthrough, but raises some puzzling questions. Single-degenerate progenitors are expected to be most prevalent in stellar populations with ages between 0.2 billion and 2 billion years, whereas double-degenerate progenitors should be common in stellar populations of all ages upwards from about 30 million years[9,10]. The stellar population