# The Densest Star

*Astronomy*

WILLEM J. LUYTEN in *The Pageant of the Stars* (Doubleday, Doran):

The companion to Sirius gives 400 times less light than the sun, and has been shown, from observations made with the spectroscope, to be much hotter on the surface than the sun. Thus it gives more light per square inch than the sun, and from its low total luminosity we calculate that it must be a very small body, not any larger in size than the planet Uranus. On the other hand, we have ascertained that it weighs almost as much as the sun. From the combination of its size and its weight we derive its density and find the amazingly high figure of 27,000 times that of water. This remarkable star is made of such exceedingly dense material that one cubic inch of it weighs about half a ton; it is 1,500 times as heavy as gold! Strangely enough, however, when we examine its light in the spectroscope we find that in the outside layers of the star hydrogen abounds, the lightest of all gases, ten thousand times lighter than water. The explanation? Quite simple, if we only stop to consider that all matter, as the latest physical theories maintain, is really full of holes. Hydrogen, the simplest form of matter, is made up of a very small, and very heavy, central particle, the *proton,* around which revolves another, much lighter particle, the *electron,* the combination forming a miniature planetary system. Other chemical elements, though more complicated, are essentially built up of combinations of protons and revolving electrons.

Under ordinary circumstances these multitudes of electrons whirl around the central core so fast that they set up a barrier through which nothing can penetrate, with the result that the size of a particle of matter is determined by the size of the largest orbit of the electrons. Under normal conditions the size of the smallest particle of hydrogen, of an *atom* of hydrogen, is about four one-billionths of an inch; consequently, we could never compress hydrogen gas more tightly than by lining up four billion atoms per inch. Compared with the size of such an atom, an electron is again totally insignificant; it is at least 10,000 times smaller, and the whole structure resembles, as Sir Oliver Lodge so felicitously expressed it, "a fly in a cathedral." The best we can do under ordinary circumstances is to compress the atoms until the cathedrals touch; beyond that point we cannot go. Deep in the interior of a star, however, things are different, and conditions are not "normal." Here we meet temperatures of several million degrees, temperatures which have the effect of exciting the electrons into violent agitation, so violent indeed, that instantaneously all the electrons are rudely separated from their protons. The two no longer belong together and each pursues its own destiny, entirely independent of the other; in other words, the walls of the "cathedral" collapse, and all that remain are the "flies." We can begin compressing again, and, instead of finding our limit when the cathedral walls touch, we can now go on until the flies touch; obviously, we can thus attain far greater densities than ever before. Especially, since the walls of the cathedrals were not real walls; they were merely barriers set up by the fast whirling motion of the electrons. In other words, the cathedrals were built of the thinnest tissue paper, the flies made of compressed platinum. Matter under normal, terrestrial conditions is comparable to a city, built of tissue-paper cathedrals touching each other; under the severe strain of the high temperature inside a star the city has collapsed and only the small flies buzzing inside are left. This is, in all probability, what has happened to the faint companion star of Sirius. In its interior the temperature is so high that the electrons and protons have severed their relationship, and the result is a density of 27,000 times that of water.

According to relativity, a star of this extreme density must affect the rays of light emanating from it, since the strong gravitational attraction at its surface makes the light waves indolent; they vibrate slower, and appear shifted toward the red in the star's spectrum. Observations made by Adams at Mount Wilson have indeed borne out this prediction, thus proving not only the correctness of the calculated high density but also of the relativistic deductions.

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The earliest known medicinal use of cinchona bark, from which quinine comes, was in 1638 when the Countess of Chinchon, wife of the governor of Peru, was cured of fever by its administration.


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