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THE ERA OF THE FOUR ROYAL STARS

An Episode in the History of Astronomy

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After lunch at the Faculty Club one day not long ago, I joined a group of half a dozen men, every one of them a recognized authority in his special field and all good friends. Those who were still in active service were free from classroom or laboratory assignments for the one-o'clock period and were therefore able to indulge in a little leisurely talk or reading. As would be expected, under such conditions, our talk was desultory and ranged widely, and it was punctuated by occasional lulls during which we sat just enjoying the friendly atmosphere.

During one such lull, I turned to the man at my left, one of the best known astro-physicists in the country, and with studied casualness asked: "When did you last observe the Four Royal Stars?" It was a second or two before my question registered. Then: "What's that you are saying about *Royal* Stars? *Four* Royal Stars? Have *I* observed Four Royal Stars? Never heard of them. What are you talking about?"

I had fully anticipated some such reply, and, in substance, it is the one that would have been given by almost any astronomer, professional or amateur, unless he had made a special study of the early history of astronomy; for the Four Royal Stars had been removed from their exalted positions long centuries ago and as *Royal Stars* they

have nothing to do with modern astronomy and are not even mentioned in Sir John Herschel's *Outlines of Astronomy*, first published a century ago, nor in any textbook of more recent date that I have seen.

That I do know about these stars and have known about them practically all my life, I owe to the fact that when I was about nine years old, the California General Conference of the Methodist Church assigned the Reverend Elmer Stuart to the Church in the little town of Jackson, on the Mother Lode, and to the further fact that I lived next door to the parsonage. Mr. Stuart was well read not only in early Church History but also in ancient and classical mythology, including the stories of the constellations. It was his habit, moreover, to follow regularly the brighter stars and constellations as they came into view, successively, in the evening skies. He taught me their names and told me the story of Castor and Pollux, of Orion, of the Hyades and the Pleiades and of many another famous star and star-group. The interest in the history of astronomy thus aroused led me, in later days, to read the works of such writers as Sir Norman Lockyer, G. V. Schiaparelli, and E. W. Maunder.

It was from him, too, that I first heard of the zodiac and the ecliptic and of the Four Royal Stars and their significance, and he taught me the famous lines written by the Reverend Dr. Isaac Watts, writer of many of our best known hymns, who died 200 years ago. They run, as many readers of this Leaflet know:

The Ram, the Bull, the Heavenly Twins,
And next the Crab, the Lion shines,
The Virgin and the Scales;

The Scorpion, Archer and Sea-Goat,
 The Man who held the Watering Pot
 And Fishes with Glittering Tails.

These lines, quoted from early memory, are still the best aid to memory in recalling the names and order of the zodiacal constellations, but in placing the Ram at the head of the list the good Doctor was behind the times; for the constellations visible from stations in the North Temperate zone had been named before the year 2750 B. C., the date of the earliest star-map that has come down to us, and then the Bull headed the zodiacal line.

At a far earlier date, the path of the sun among the stars in the course of a year had been mapped quite accurately and had been found to be the great circle of the heavens, which we, following the Greeks, call the *Ecliptic*. They had observed, too, that this great circle makes an angle of about twenty-three and one-half degrees with the great circle of the celestial equator. And they had noted that the moon and the five bright "wandering stars" (planets) in all their roving through the heavens, never strayed more than nine degrees north or south of the ecliptic. Two points in the eighteen-degree zone thus bounded, and later called the zodiac, assumed special significance to them, the points where the sun crossed the equator, when it went north, and the point 180 degrees farther along the ecliptic, where it again crossed the equator, on its way south. Only second to them were the two, half way between, where the sun seemed to stand still, briefly, as it reached its "farthest north" and "farthest south" before turning back toward the equator. The stars around these four points were probably the first to be grouped into constellations. To the group around the vernal equinox, where the sun crosses the equa-

tor on its way northward, they gave the name *Taurus*, the Bull, for this was (and still is) the most important point of the four and the cult of the Bull was then at its height from Babylon to Egypt. In crossing the equator northward at the vernal equinox, the sun, for these early sideronomists opened the New Year and ushered in the season of renewed fertility, the season when the rivers overflowed their banks, the season when man should begin his ploughing and the cultivation of his fields. For men like Lockyer and Maunder who had made special studies of the ancient monuments and documents that still remain have given convincing evidence that these early constellation namers lived in Armenia and Asia Minor, between the parallels of 32 and 40 degrees, north latitude, in the region roughly bounded by the Aegean, Mediterranean, Caspian and Black Seas. To these people, it was natural that the year should come in with *Taurus*, the Bull, who ploughed the fields of heaven as his great terrestrial counterpart ploughed the fields of the earth.

The stars around the autumnal equinox and those around the summer and winter solstices were likewise grouped into constellations to which the names *Scorpio*, *Leo* and *Aquarius*, respectively, were given. These four constellations were the only ones in the original zodiac; somewhat later, the spaces between them were divided into eight more, to bring the total up to the mystic number twelve. We must discriminate carefully between these twelve zodiacal *constellations* and the twelve zodiacal *signs*. The latter have nothing whatever to do with the science of astronomy, but are terms used in the pseudo science of astrology.

About the year 1800 B. C. the vernal equi-

nox passed out of Taurus, and the constellation Aries, the Ram, took over its guardianship and was still in charge of it when Hipparchus, in the Second Century, B. C., compiled his star catalogue and discovered the phenomenon (to which he gave the name *precession*) and correctly explained its cause. (See Leaflet No. 184.) That is when and why the term *First of Aries* came to be used as a synonym for the vernal equinox, a synonym that still survives although the equinoctial point passed out of Aries as long ago as 140 A. D.

Important as the vernal equinox was to the astronomers of ancient times, it is at least of equal importance to the astronomer of today, for it is the zero point from which we measure a star's *Right Ascension* eastward along the equator to the foot of the hour-circle passing through the star. Every star catalogue of precision and every orbit of comet or other body in the solar system bears the notation "For the Equinox of 1950.0," or whatever other year may be appropriate.

Now you may well ask "What has all this to do with 'The Four Royal Stars'?" The answer is readily given. The vernal equinox is not a date, as is sometimes assumed because the sun passes through it about March 21, by our calendar, nor yet a star or a constellation. It is merely a *point*, and not a fixed point at that, on the face of the sky. It moves very slowly westward along the ecliptic, taking 25,800 years for one complete circuit of the heavens. Similarly with the autumnal equinox and the summer and winter solstices. They are merely points, and to locate them, especially in days when no measuring instruments or maps were available, sign posts or guides were necessary. When the constellation Taurus was named, Aldebaran, the brightest star in that constellation was

close to and served to locate the vernal equinox. Regulus, the brightest star in Leo, in like manner pointed out the position of the summer solstice, and Antares, the brightest star in Scorpio, helped them to locate the autumnal equinox. There was no particularly notable star in Aquarius to direct them to the winter solstice, but Fomalhaut, in Pisces Australis, just across the southern border of Aquarius, served well.

These four stars, therefore, were called the *Four Royal Stars*, not because of any outstanding characteristics of their own, but simply because of their positions as guides to the four most important points on the ecliptic, and they retained their high rank for generations, because precession is a very quiet and deliberate force. It is none-the-less a force that acts continuously and it slowly but inexorably compelled these royalties to abdicate simply by drawing their thrones away from under them. They really had no choice; there was nothing for them to do but to join the ranks of ordinary stellar potentates, every one of them a monarch in his own domain, but of no more cosmical importance than scores of others. The era of the Four Royal Stars was thus brought to an end, and in the course of time well-nigh forgotten.

Just as stars, however, the four command greater interest on the part of astronomers now than ever before. All that early astronomers could learn about them was what they could see with their unaided eyes. Like all other stars, they were apparently fixed on the face of the sky; they were the brightest stars of their own constellations but, at that, were not extraordinarily brilliant, all four, nearly equally bright, being just a little fainter than a standard first magnitude star, and only one, Antares, was notable for its color, which was

strikingly red. Of their intrinsic properties they could know nothing. The development of modern methods and instruments has changed all this. We know that the stars are all in motion, we have been able to measure the parallaxes or distances of many of them and to study their chemical composition, their temperatures, masses and densities and their true or effective radiating power and we are constantly adding to our knowledge.

Take the four stars in question. From their parallaxes, we are able to say how they would compare in brightness if they were all viewed from some standard distance. The standard distance adopted by astronomers for such comparisons is 10 *parsecs*, or the distance through which light, if unobstructed, travels in 32.6 years. Placed at this distance from us, the sun would shine as a star of 4.85 magnitude, just easily visible to the unaided eye on a clear, moonless night, Aldebaran, actually distant 75 light years, would give 90 times as much light as the sun and Antares 3400 times as much. Formalhaut and Regulus, distant 20 and 70 light years, are nearly normal stars, white in color, and are respectively, 13.5 and 150 times as bright as the sun. Though they possess many interesting properties they may be passed here.

Aldebaran and Antares are far more amazing stars. Both belong to the comparatively small class of low density giant stars and to the still smaller group of stars with diameters large enough to be measured directly with the great interferometer on Mount Wilson. Aldebaran is an orange-colored star of spectral class K5; Antares, distant 230 light years, is a red star of class M1. From the data now available, it appears that Aldebaran has a diameter of 37,000,000 miles, whereas the sun's diameter is only 864,000, an effective radiating

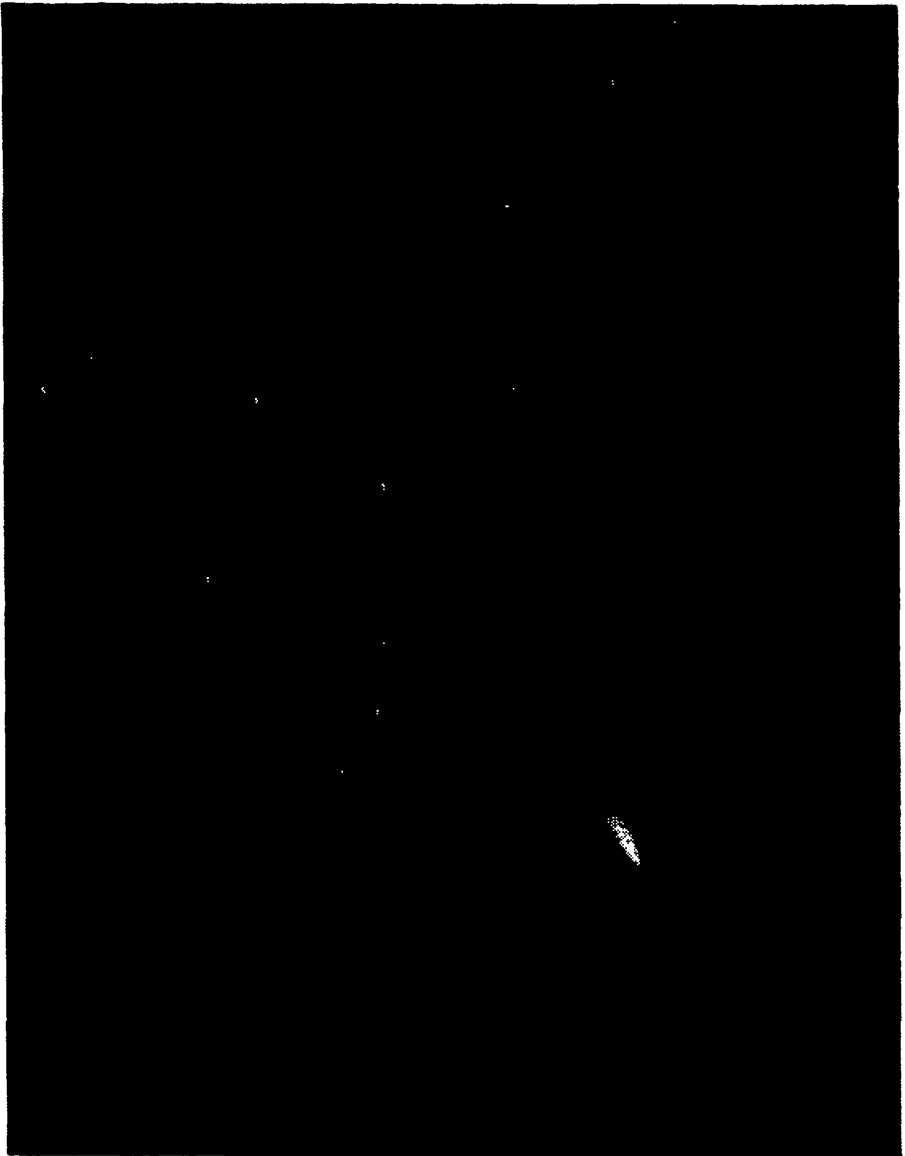
temperature of only 3400 degrees as compared with the sun's 6,000, a mass four times that of the sun, and a density only 0.000,05 times that of the sun. Remarkable figures; but those for Antares are even more extraordinary. It has a diameter of 290,000,000 miles, or 330 times that of the sun, an effective radiating temperature of only 3100 degrees, a mass, despite its enormous volume, only 15 times the sun's mass, and therefore the almost incredibly low density of only 4 ten-millionths the sun's density. There are a few stars known to be even less dense, but Antares is tenuous enough to pass comprehension.

Antares, furthermore, is a visual binary star, with a white companion of 5.5 apparent magnitude about 2".5 distant, the two bodies describing closed orbits about a common center. My figures relate only to the giant red primary.

The figures I have given must not be taken as final values. In the nature of the case, they can only be approximations to the truth, for they rest ultimately upon measurements of extremely small quantities, which are affected by relatively large probable errors. I believe, however, that they are near enough to the truth to show that Aldebaran, Regulus, Antares and Fomalhaut, though they may no longer claim the title of the *Four Royal Stars*, are nevertheless truly regal bodies.

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Photograph of the new bright comet 1947 discovered in the southern sky. Taken by E. Casal, 11 December, 1947. Exposure 15 minutes.—*Montevideo Astronomical Observatory.*