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FATHER ANGELO SECCHI
A NOBLE PIONEER IN ASTROPHYSICS

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In a small Italian town near Bologna, on July 18, 1818, Angelo Secchi was born. His parents were honest folk of pious sentiments and highly respected by their fellow citizens. The young Angelo soon showed his power of observation and an uncommonly lively intelligence and temperament which made them see in him his future vocation.

Given a start in his studies in his home town by Jesuit fathers, he made rapid progress in his classical and scientific education. At the Collegio Romano, the great university of the Jesuits, he continued his humanistic and theological studies. His teachers also cultivated his passion for scientific studies. In March, 1848, the Jesuit order was banished from Rome and Father Secchi was forced to continue his studies first at the Jesuit College at Stonyhurst in England and then at Georgetown College near Washington, D.C., where Father Curley interested him in theoretical and practical astronomy.

His stay in the United States was brief because in 1849 the restrictions on the Society of Jesus in Rome were lifted and the Observatory of the Collegio Romano called upon Father Secchi to reactivate its astronomical work as successor to Father

De Vico. Immediately he began work in the fields of astronomy, astrophysics, and geophysics, bringing world fame to the well-known observatory.

Secchi had clearly in mind a program for the new observatory which should be supplied with suitable up-to-date instruments. Since the great 17-meter dome planned for the Church of San Ignazio at one corner of the Collegio Romano had not been completed, he was able to use the massive supporting piers for his observatory.

In a memoir prepared for the 25th Anniversary of the new observatory Father Secchi describes the situation in astronomy at the time he returned from exile and explains his program thus:

"Physical astronomy was almost an abandoned field at the time we were called to direct the Observatory of the Collegio Romano, wherefore, we resolved to dedicate ourselves to it.

"Furthermore, this kind of research already had many valuable precedents in Rome. The discovery of many comets during the directorship of Father De Vico and the work on the satellites of Saturn and the rotation of Venus had already pointed out the field in which science could be served from an establishment which certainly could not be considered well-endowed. We, after several months of endeavor, concluded that research in precise astronomy was a waste of time and energy; so we had to limit ourselves mostly to comet research, and to studies of the physical appearance of the sun and other celestial bodies.

"This concept was the one that governed all our later research and the choice of instruments for the new observatory. According to some this was going too far and it was even said at the Collegio Romano that the science of physics rather than that of astronomy was being cultivated. Physics of the

stars, then in its infancy, has matured in the 25 years since the observatory program began and this institution had some part in its advancement."

The 24.5-cm equatorial telescope, made by the famous optician Merz, was placed in the larger dome of the new observatory which was built in 1852. The dome turned on eight cannon balls revolving between two circular rails of cast iron. The size and excellence of the lenses by Merz indicate that Secchi had a research tool powerful for that epoch. In another dome the Cauchoix telescope, which was devoted particularly to the sun, was located. Observations were made by projecting the direct solar image to 24-cm diameter and by adapting various types of spectroscopes to the telescope.

In 1859 Secchi observed Mars intensively, discovering two permanent dark "canali" between the two large equatorial continents. To him we owe the name "canali", later adopted by Schiaparelli. Applying the spectroscope to the planets, he showed that in the spectra of Jupiter and Saturn, besides the lines due to water vapor, there were other bands, especially in the red region, and he concluded that their atmospheres were "not yet purified and had elements different from ours." In the spectra of Uranus and Neptune he noted the presence of bands of the same character but more intense than those of Jupiter and Saturn, due to substances not yet identified. The sun, the only star whose surface we can see with an appreciable diameter, occupied Secchi's attention for many years. His solar studies were crowned by his monumental publication *Le Soleil* issued in two volumes beautifully printed in Paris in 1875 and 1877. The work was first written in Italian but later, for the benefit of readers in other countries, rewritten

and translated into French.

Rereading this book today, we are truly astonished at Father Secchi's observational acumen and his capacity for drawing conclusions, several of which are valid today in the light of modern research. Spectral analyses of the solar atmosphere enabled him to conclude that it is composed of many metals, for the most part the same as those known on the earth, although many Fraunhofer lines were unidentified. Nevertheless, he noted that the materials which compose the universe must be much the same in its various parts and the temperature of the sun must be high enough to volatilize all the substances of which it is made. This idea together with the examination of stellar spectra brought him to the concept of the unity of the material which forms the universe and of its physical forces.

Total solar eclipses interested him greatly. In order to observe the eclipse of 1860 he betook himself to the east coast of Spain where he took the first photographs of the solar corona. By comparing his observations with those of other observers he proved that the prominences are real phenomena and not effects of lighting as some believed; that they belonged to the sun; and that the corona too is a real phenomenon.

In 1868 Secchi repeated the experiment made by Janssen and Lockyer by observing prominences in full sunlight with a spectroscope having a widened slit and immediately recognized the importance of continuing them regularly. Daily drawings of sunspots and prominences over the whole sun became a routine program of the Observatory of the Collegio Romano. These drawings constituted the "*spectroscopic pictures of the solar rim*" published with international collaboration for

many years by the Society of Italian Spectroscopists. These pictures were used for an exhaustive study of the distribution, area, and frequency of the prominences. They distinguished, as we still do between quiescent and eruptive types and showed, the relationship of spots.

In the history of physical astronomy even more outstanding than Secchi's pioneering and laborious investigations of the solar system is his epoch-making success in observing and classifying the spectra of the stars. His skill in observing and his wisdom in interpreting his findings in this field where only observations of a few stars had been made before, chiefly by Donati, Rutherford, and Huggins, excite our highest admiration.

In a letter to the Pontifical Tiberine Academy, on January 27, 1868, Secchi wrote, "I wanted actually to see whether, since stars are countless, their composition still varied proportionately. This was my goal; and having been fortunate enough to perfect the observational instruments, the results have been fruitful beyond all expectations."

The instrument to which he refers was a slit spectroscope attached to the 9-inch Merz refractor. At the eyepiece was a direct-vision dispersing unit with several prisms and a cylindrical lens for widening the spectrum. All observations were visual. Once a spectral type with certain identifiable lines had been recognized in some principal stars he thought others with similar characteristics could be found. For the spectra of the fainter stars he made use of an objective prism which he thus described: "The instrument which we have provisionally set up for these investigations has a flint prism, six inches in diameter with an angle of refraction of about 12°. It is placed in front of the nine-inch objective of the big refractor. Rea-

sons of economy limited us to this size, thus sacrificing more than half the aperture of the refractor itself. However, the results are most satisfactory; the light so transmitted is brighter than that received through a direct-vision prism inserted between the objective and the eyepiece, in spite of the fact that the dispersion is more than quadrupled. It is the work of Mr. Merz of Munich who is said to have had no little trouble in making it; this I can believe because it is of rare precision."

The most important and salient fact emerging in a short time from the observations of spectra of the brightest stars is thus described by Secchi: "Although stars are countless, yet their spectra reduce to a few forms, well-defined and distinct, which for brevity we call 'types'. Examination of stars has occupied us for several years; almost all bright ones and many, many others; at least 4000 in all since besides the principal stars the whole region around was examined." In this way the discovery of his famous types, from the hottest to the coolest, came about, yielding a glimpse of the possibility of a real evolution of the celestial bodies themselves.

As a result of this extensive survey of most of the naked-eye stars he found that the spectra could be described by grouping them in four classes or types as illustrated in Figure 1.

Secchi's Spectral Types

Type I. Spectra showing strong hydrogen absorption lines, like Vega. White stars. (Harvard Classes B, A, and early F).

Type II. Numerous dark lines, like the sun or Arcturus. Yellow stars. (Classes F5, G, K, and K5).

Type III. Wide dark bands, deepest at the violet edges, like Alpha Herculis. Red stars. (Class M).

Type IV. Dark carbon bands more definite at the red edges, like 19 Piscium. Very red stars. (Class N).

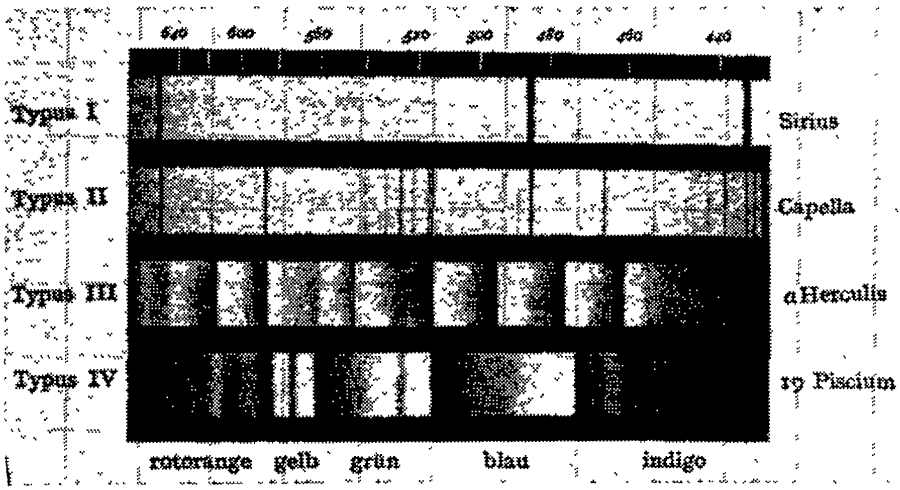

Fig. 1 — Secchi's four types of stellar spectra. (From Graff, *Grundriss der Astrophysik).*

For about 50 years Secchi's spectral types were generally used by astronomers everywhere until they were finally replaced by the more detailed Harvard classification system.

Secchi foresaw future research of great importance with powerful instruments; especially, if these were located at suitable sites "as, for example, on Etna or other high mountains where the atmosphere would be really pure and the astronomers would not persist in staying in the middle of capital cities or their vicinity where the atmosphere, besides its density, is burdened with filthiness and absorbing vapors."

He also assiduously observed the nebulae which he classed as "planetary, irregular, and elliptical." He recognized, 40 years before Barnard, the pres-

ence of obscuring matter scattered over the sky and in the "elliptical" nebulae. Indeed, alluding to the observations of W. Herschel, he noted that up to that time, the dark areas were called "black holes," but such an explanation seemed to him "quite improbable, especially after the discovery of the gaseous nature of the nebular areas and it is instead more probable that this blackness results from a dark nebulosity projected on a lucid background and intercepting its rays." Also, in observing the Andromeda Nebula, he noted that the two black channels were probably two zones of dark absorbing material projected on the nebula itself, just as found in some regions of the Milky Way.

He died in his room at the Collegio Romano on February 25, 1878, near the instruments he had used so much. One may see today in the church of San Ignazio on the urn which holds his ashes the red ribbon of the decoration hung on his chest by Napoleon III at the Paris Exposition in 1867 when he bestowed the gold medal on Father Angelo Secchi.

The vast total of his astrophysical results seems to represent the output of a scientific corps rather than that of one individual. Above all, Father Secchi believed *A caeli conspectu ad Deum via brevis* (Contemplation of the heavens is a short way to God).

A happy and wise union of science and faith was always the chief purpose in the holy life of this churchman who may well be considered one of the great pioneers of astrophysics.