the study of skeletal material, and, in particular, of crania.[2] I see no reason why it can not be applied equally well to the analysis of data gathered upon living subjects. It is a laborious method involving a large amount of calculation, but necessitating no extensive knowledge of higher mathematics. I have little faith in short-cut methods and no use whatever for personal impressions unsubstantiated by metrical and morphological data properly reduced. If physical anthropologists wish to achieve scientifically valid results they must not content themselves with the presentation of tables of raw measurements, supplemented by their personal reactions by way of interpretation.

If races differ quantitatively in intelligence and qualitatively in psychological characteristics, such differences can be established only by the segregation of pure racial types and the subsequent investigation of their psychological attributes.

E. A. HOOTON

PEABODY MUSEUM,
CAMBRIDGE, MASSACHUSETTS

POPULAR ASTRONOMIC EDUCATION IN EUROPE[1]

IT was my privilege to visit astronomical observatories from the University of Upsala in northern Europe to the Vatican in the south, thus establishing contacts with the directors and other astronomers, and conferring with them about our project at the American Museum. All the astronomers that I visited showed a real interest in our proposed astronomical hall, and some contributed practical suggestions of value.

OBSERVATIONS

The director of the Vatican Observatory, Father J. G. Hagen, who by the way is a naturalized American citizen, strongly recommended the installation of a small telescope which could be used by visitors for viewing objects in the sky. This would not be for professional astronomical work, however, as our institution should not be an observatory, but rather a museum of astronomy. The objective lens of this telescope need not be larger than five or six inches in diameter. This advice of Director Hagen is strengthened by the popularity of the so-called *Uranias* of Europe. I am convinced that this is an excellent proposal and hope that place can be found for a small dome in which may be installed such a telescope.

Professor Elis Strömgren, director of the Astronomical Observatory at Copenhagen, had visited the Zeiss Projection Planetarium in Munich and was tremendously impressed with it, and several astronomers advised me to visit the *Urania* in Berlin, as well as the one in Vienna and the one in Zürich. These *Uranias* are popular observatories in which the people may, for a small fee, observe on any clear night celestial objects through a fair-sized telescope. These observations are aided and directed by a trained person who explains what is seen. When the sky is clear enough for observation, a red light is shown on the *Urania* building. Usually two lectures with observations are given, one rather early in the evening (eight to nine o'clock) and one rather late (ten-thirty to eleven-thirty o'clock). There was a large sign at the door of the Vienna *Urania,* stating that if the sky was clear on that night the following objects could be satisfactorily seen: Jupiter, Uranus, the star-clusters in Perseus and the great nebula in Andromeda. The *Uranias* are also open during certain hours of the day for the observation of sunspots with the astronomical telescope and for the viewing of mountains and other distant objects with a terrestrial telescope. How well established these *Uranias* are in Europe is indicated by this significant fact that both in Vienna and in Zürich the street passing the *Urania* is called *Uraniastrasse.*

The Astrophysical Observatory at Potsdam is one of the best constructed, one of the most complete and one of the most modern of those visited in Europe. Here, among other things, I examined their new Einstein Tower, which they believe to be an improvement on the one at our Mt. Wilson Observatory. With this equipment they will test the Einstein theory by measuring the displacement of the Fraunhofer lines, the spectrograph connected with this tower being very much more efficient than that connected with any refracting or reflecting telescope. The spectrum is spread out in a large room, which no one enters, and which is kept at a temperature constant to one one hundredth of a degree.

In Florence the Astronomical Observatory and Galileo's tower, which is restored, were visited. In the Museum of Physics I was greatly interested to see the two original telescopes of Galileo, with which he first saw the moons of Jupiter, the fiery ring of Saturn, the spots on the sun, the mountains on the moon, and Venus as a waxing and waning crescent.

[2] This method has been employed in the author's recent publication "The Ancient Inhabitants of the Canary Islands," Harvard African Studies, Vol. VII, Peabody Museum, Cambridge, Mass., 1925.

[1] In preparation of the plans for the Hall of Astronomy, for the use of students of all grades, which is now under consideration by the trustees of the American Museum of Natural History, Dr. G. Clyde Fisher was sent abroad during the summer of 1925. There is here printed an abstract of his report.

The director of the museum of physics allowed me to photograph these telescopes. In two museums visited—the German Museum in Munich and the Science Museum in South Kensington, London—there are models or replicas of Galileo's telescopes. Similar models would be objects of interest in our astronomical hall.

In the Paris Observatory our own astronomer, George W. Ritchey, who made the 100-inch disc for the big reflector at Mt. Wilson, was at work, attempting to make much larger discs than ever have been made before and on an entirely different principle. His new discs are of glass, but they are not solid. They are made of many pieces in such a way that the completed disc is ventilated and very much lighter than the old solid discs. The Paris Observatory is famous for its astronomical records, especially those dating back to the early days. It is also famous for its international time department, in which every instrument was demonstrated for me. Among other things, permanent records were being made of radio signals from Annapolis.

ASTRONOMIC MUSEUMS

More important to me than astronomical observatories, and more important even than *Uranias,* were astronomical museums, the greatest of which was the department of astronomy in the German Museum in Munich. There is no doubt that this is the finest museum of astronomy in the world. Here more than twenty rooms, halls, terraces and domes are fitted with objects of astronomical interest. No guide-book or catalogue of these exhibits was to be had, except a partial or fragmentary one in the general guide-book to the museum. So, after several hours of concentrated work, I made a complete list in considerable detail of these exhibits. There is not space in this report for even a bare list of these, but I hope to go over them quite carefully with Mr. Howard Russell Butler, advisor to the architects. Here were found a number of things which Mr. Butler had thought of independently, for example, a large lunar landscape about four feet wide and ten feet long, in black and white, showing the earth in the sky. We shall expect Mr. Butler to make a much finer one and in natural colors. Another exhibit represented the sun as a star with fifteen or twenty of its nearest neighbors, all shown in relative *sizes, colors, distances* and *directions,* by small balls suspended by fine wires. The balls were red, yellow and white. The sun, being a yellow star, was represented by a yellow ball. Double stars were shown by two balls.

In this collection is a Ptolemaic planetarium in a spherical glass globe about six feet in diameter, with constellations shown on glass sphere—the earth stationary in the center and the sun, moon and the planets known at the time this theory prevailed revolving about the earth, each planet on its epicycle. There is a crank on the outside of the sphere with which visitors may turn the whole apparatus—an excellent mechanism.

In another room is a Copernican Planetarium of the same size, with the constellations on the glass sphere, the sun in the center, with all eight planets with their satellites, all geared properly, revolving around it. A crank on the outside for turning the apparatus completes this excellent mechanism.

The feature of the crank on the outside of these pieces of apparatus, which can be turned by the visitor, adds greatly to his interest and understanding. A similar crank was to be found attached to apparatus for showing the phases of the moon.

In another room is a large Copernican Planetarium, made by the Carl Zeiss Optical Works, without doubt the largest and best in the world. A lighted globe in the center represents the sun. The six planets nearest the sun with their satellites, the planets and satellites all revolving at their proper relative speeds are shown. The diameter of Saturn's orbit is twelve meters. Uranus and Neptune are left out, presumably because their tremendous distances would make the rest so small proportionately. There is no light except from the central sun, and the walls, ceiling and floor are painted black. Consequently day and night are well shown on any of the six planets, and our moon goes through its phases with realistic clearness. For the lecturer or demonstrator, a car travels around under the earth, which goes around the sun in twelve minutes, the apparatus being propelled by an electric motor. A periscope makes it possible to see the phases of Mercury and Venus on the plane of the ecliptic. Constellations of the Zodiac are shown in a belt on the wall, with their names in white letters and with the degrees of the circle marked. The stars are shown by lights back of small, round holes in the black wall.

In one room more than one hundred kinds of sun-dials were exhibited, and on an adjoining terrace the four principal types of sun-dials were set up for actual service out of doors. On clear days these attracted the attention of visitors. On this terrace there were also a sun-chronometer, a Gnomon for determining the middle of the day (noon) and the day of the year, and a glass-covered house containing two meridian-circles and a chronograph.

The evolution of the refracting and the reflecting telescopes is shown in one room, illustrated for the most part by real telescopes. Galileo's original telescope is shown in replica only. However, the original telescope of Simon Marius, with which he saw the

moons of Jupiter in 1610, the same year in which Galileo first saw them, is here. Four original instruments of Tycho Brahe are also in this room.

The new Zeiss Projection Planetarium is the most impressive and consequently the most popular piece of apparatus in the whole astronomical department. The dome is ten meters or a little more than thirty feet in diameter. They have two lecturers, who together give nine demonstrations a day. We attended one of these, at which a part of the audience was made up of a large class of pupils from a parochial school accompanied by two or three sisters. This type of planetarium will be described later when my visit to the Carl Zeiss Optical Works at Jena is discussed.

In the Science Museum at South Kensington, London, is an astronomical department, but not nearly so large or so interesting as that at the German Museum in Munich. However, one should mention two telescopes made and used by Sir William Herschel, as well as a number of other pieces of apparatus used by the Herschels. The first permanent photographic negative ever produced is here. It is a photograph of the 40-foot reflector at Slough and was made in 1839 by Sir John Herschel. A print from it is framed from rungs of the ladder of the mounting of Herschel's 40-foot reflector at Slough.

A complete list was made of the exhibits in the astronomical department of the Science Museum at South Kensington. All the transparencies in this museum were made from negatives made at the Royal Observatory at Greenwich. We have much finer ones made through our big American telescopes.

At Vienna, in the Natural History Museum, I examined the collection of meteorites, which is said to be the finest in the world, and was impressed with the fact that so many of their specimens had fallen in the United States. Our acting director, Mr. Sherwood, informs me that Ward's Natural Science Estalishment was probably instrumental in sending many of these meteorites to Vienna.

PLANETARIUM PROJECTION

The main object of my trip to Europe was to visit the Carl Zeiss Optical Works at Jena and to examine carefully the new projection planetarium made by this firm. The first instrument of this kind was made for the German Museum in Munich and was merely mentioned above. The second is located upon the roof of one of the buildings of the Carl Zeiss Works. The dome is larger than in the first, being sixteen meters or about fifty feet in diameter, and affords seating room for 280 persons, although in the excitement of the first days as many as 600 persons, more than half standing, were packed into this dome, and as many as twelve lectures and demonstrations a day were given. The dome is hemispherical in shape and is white inside, and in the center is an optical projection apparatus which throws on the inside of the dome images of the sun, moon, all the planets which are visible to the naked eye, and the 4,500 fixed stars that are visible to the naked eye, including the Milky Way. These projected images move as the real bodies appear to move in the sky, with the time accelerated due to rotation of parts of the central apparatus, which is so accurately made that it takes care of the precession of the equinoxes. The erratic motions of the planets in the sky as seen by the naked eye from the earth are visualized much more satisfactorily than by the old-fashioned planetarium. In fact, the former types of planetaria are crude indeed in comparison.

The phases of the moon are just as clearly shown, but most impressive of all is the realistic appearance of the fixed stars, including the Milky Way. In the public demonstrations at Jena the audience was sometimes composed largely of school children. Whether the audience was made up of children or of adults when the fixed stars were turned on an involuntary "Ah" swept over the assembly and they were spellbound. It seems that no one is prepared for such a realistic representation, and I was no better prepared than others. In short, I was astonished, overwhelmed. The illusion of the immensity of space is perfect. One feels that he is in the great outdoors under a clear night sky. Due to some subconscious imagination, perhaps—at least for some psychological or physiological reason, this artificial sky seems to possess the deep night blue seen in the real sky, and yet there was no blue color on the inside of the dome and none in the projection apparatus. On being congratulated upon the mechanism, Dr. Ing. W. Bauersfeld, the inventor, admitted that the illusion of the immensity of space and the realistic representation of the fixed stars, including the Milky Way, had exceeded even his expectations. And Dr. A. Villinger, head of the department of astronomy in the Zeiss Works, was an unbeliever until the apparatus was finished and demonstrated. He thought it would be little more than toy until he saw it demonstrated.

By means of a special set of projectors the names of the constellations can be shown in the sky, and with a flashlight showing an arrow-shaped light the lecturer can point out any star, planet or other body in the sky.

During several days spent at the Carl Zeiss Works I was given every facility for examining this new invention, including several private demonstrations, besides the opportunity of attending a number of public demonstrations. For the latter they have five lecturers, young men with technical training who dur-

ing part of their time are otherwise engaged in the Zeiss Works. Full notes were made concerning the apparatus, its installation, its demonstration and its adaptation to our astronomical hall at the American Museum.

In early September eleven of these planetaria had been sold to cities in Germany, and negotiations were in progress with other cities of Europe. Within a few days they expected to close a contract with Vienna. One of the planetaria in the process of building was seen and photographed in Prinzessinen Park in Jena. In this the dome is twenty-five meters, or a little over seventy-five feet in diameter, almost exactly the same diameter as the dome planned for our astronomical hall. In the one at Düsseldorf the dome will be thirty meters or over ninety feet in diameter. For projectional reasons this is considered the maximum limit in size.

Having read an enthusiastic description of the apparatus and on account of the confidence inspired by the fact that it was made by the Carl Zeiss Optical Works at Jena, I approached this investigation with a tendency toward a favorable consideration. Determining, however, to hold this feeling in check and to approach the matter with an open mind, I made the examination with care and thoroughness. As a result I am enthusiastically in favor of securing a Zeiss Projection Planetarium for our new astronomical hall. Judging from the experience at Jena and at Munich I believe it will attract more people to the museum than anything we have ever had here. When it becomes more widely known it is sure to come to America. May the first one come to the American Museum of Natural History!

G. CLYDE FISHER

AMERICAN MUSEUM OF NATURAL HISTORY

EDWARD FULLER HOLDEN[1]

WHILE on a vacation trip with his family, parents and friends, Edward Fuller Holden was drowned at North Deer Isle, Maine, August 5, 1925. In the tragic death of Dr. Holden the department of mineralogy of the University of Michigan lost a valuable member of its staff and the science of mineralogy an energetic investigator with unusual promise for splendid achievement. Dr. Holden is survived by his widow, Beatrice M. Holden, and three small sons.

Edward Fuller Holden was born at Woonsocket, Rhode Island, August 28, 1901, where his father, Amasa Amidon Holden, was principal of the high school. His mother, Mary Barnes Holden, is a direct descendant of Edward Fuller, of the Mayflower group. Dr. Holden's early training was obtained in the schools of Woonsocket, and of York, Pennsylvania, where the family removed in 1913. After completing the high-school course in the latter city, Dr. Holden entered the Pennsylvania State College in January, 1918, where he enrolled as a student of mining engineering. His unbounded energy and exceptional ability as a student permitted him to complete the high school and college courses in seven years. He received the degree of bachelor of science from the Pennsylvania State College in 1921. His advanced degrees were conferred by the University of Michigan, the degree of master of science in 1923 and that of doctor of philosophy in 1925.

At an early age Dr. Holden evidenced great interest in minerals, which was stimulated by a course in general science pursued in the eighth grade. Throughout his high-school course this enthusiasm developed to such an extent that before entering college he submitted for publication in the *American Mineralogist* a short paper on the occurrence of quartz crystals. As an undergraduate student Dr. Holden decided upon a career in mineralogy and accordingly chose his studies with that goal in view. His ability as an investigator now began to manifest itself and by the time he received the baccalaureate degree he had prepared six papers on mineralogical topics which appeared in the *American Mineralogist*. From the autumn of 1921 until his death Dr. Holden held the position of instructor in mineralogy and during this period earned his graduate degrees.

While a student at the Pennsylvania State College Dr. Holden became interested in the cause of color in minerals, and to this problem he devoted much of his time at the University of Michigan, making notable contributions to its solution. His papers on the cause of color in rose quartz, smoky quartz and amethyst established a new standard for publications in this field. Dr. Holden's thorough training in the various phases of mineralogy and in chemistry and physics permitted him to approach this problem from several standpoints, as had not been the case with many of the earlier investigators of this subject. His paper on the pigmentation of amethyst was awarded the Walker prize for 1925 by the Boston Society of Natural History and was adjudged as being of unusual merit. Had Dr. Holden been spared to continue his researches he would have undoubtedly contributed much toward clarifying the perplexing problem of the cause of color in minerals. At the time of his death Dr. Holden had published sixteen papers and in addition had collaborated with me in the preparation of a text-book on "Gems and Gem Materials," which was published shortly after his death.

In 1921 Dr. Holden began abstracting papers on

[1] Presented before the Mineralogical Society of America, at New Haven, Conn., December 29, 1925.