BOŠKOVIĆ, RUDJER J. (*b.* Dubrovnik, Yugoslavia, 18 May 1711; *d.* Milan, Italy, 13 February 1787), *natural philosophy, mathematics, astronomy, physics, geodesy.*

Bošković was perhaps the last polymath to figure in an important way in the history of science, and his career was in consequence something of an anachronism and presents something of an enigma. He stands between the natural philosophy of Newton and Leibniz at one extreme and Faraday and field theory at the other, but too far from both for the connection either forward or backward to appear a coherent one. A somewhat isolated figure, he belonged to no definite eighteenth-century tradition. Croatian by birth, he became a Jesuit; and like many intellectuals from the Dalmatian cities, he was drawn to Italy and lived the first part of his career in Rome. A man of the Enlightenment, he sometimes gives the effect of a Renaissance scholar moving about Europe from place to place for reasons of circumstance and patronage and departing on great journeys at critical junctures. As will appear from consulting his bibliography, he published in the mode of an earlier time. He wrote treatises on whole sciences, and at certain periods in his life composed several such works in the course of a year. Nevertheless, his reputation has been rather that of a forerunner than a survival. His doctrine of atomism which modified the massy corpuscles of Newtonian natural philosophy into immaterial centers of force appeared to foretell, and there are historical reasons to believe that it actually influenced, the basic position of nineteenth-century field physics in regard to the relations between space and matter.

Life. Bošković was the son of Nikola Bošković, a merchant of Dubrovnik, and Paula Bettera, the daughter of Bartolomeo Bettera, a merchant originally from Bergamo, Italy. The family was of average means and was noted for its literary interests and accomplishments. Bošković began his education in the Jesuit college of Dubrovnik and continued it in Rome, first at the novitiate of Sant'Andrea, which he entered in 1725 at the age of fourteen, and later at the Collegium Romanum. He was extraordinarily sharp of mind, comprehensive in intelligence, and tireless in application—in short, an outstanding student. He learned science in a way characteristic of his later career, through independent study of mathematics, physics, astronomy, and geodesy. In 1735 he began studying Newton's *Opticks* and the *Principia* at the Collegium Romanum, where he made himself an enthusiastic propagator of the new natural philosophy. The exact sciences were what always appealed to him—in the first instance mathematics. In 1740, although he had not yet completed his theological studies, he was appointed professor of mathematics at the Collegium Romanum. That event largely determined the course of his career. Teaching interested him in its methods as well as for its content. In this respect, as in others, his spirit was progressive. He published a textbook of his teaching in 1754—*Elementa universae matheseos*—of which the third and final volûme contains an original theory of conic sections.

During this period of his life Bošković undertook, as was customary among qualified clergymen of his time, several practical and diplomatic commissions for lay or ecclesiastical authorities. The cupola of St. Peter's having developed alarming fissures, a commission was appointed consisting of Bošković and two fellow "mathematicians," F. Jacquier and Th. Le Seur, to investigate the causes and make recommendations. Bošković drafted the report which, analyzing the problem in theoretical terms, achieved—despite certain errors—the reputation of a minor classic in architectural statics. Thereafter the papal government entrusted the planning for draining of the Pontine marshes to Bošković. He composed a series of memoirs on the practice of hydraulic engineering, on regulation of the flow of the Tiber and other streams, and on harborworks. He did a plan for the harbor at Rimini in 1764 and for that at Savona in 1771.

Archaeology also interested Bošković. In 1743 he discovered and excavated an ancient Roman villa above Frascati in Tusculum, and in 1746 published a description of a sundial that had been among the finds. In 1750 he also published a critical study of the Augustan obelisk in the Campo Marzio. In 1757 Bošković undertook the most important of his several diplomatic missions, representing the interests of the Republic of Lucca before the Hapsburg court in Vienna in a dispute with Tuscany over water rights. He won the case, and in the intervals of tending to its ramifications, he also while in Vienna completed his major work in the field of natural philosophy, *Philosophiae naturalis theoria,* which appeared in the autumn of 1758.

As the years went by, Bošković fell out of sympathy with certain policies of his ecclesiastical superiors. He resented their rejection of proposals he had advanced looking to the modernization of education both in method and in subject matter. He disliked the Vatican's reaction to the persecution of his order in Portugal. He was disappointed by the negative attitude that a number of Jesuit philosophers—Peripatetics he thought them to be—adopted toward his own system of natural philosophy. It seemed time for a move. The Academy of Sciences in Paris had long since elected him to corresponding membership—he was correspondent of Dortous de Mairan—on the publication in 1738 of his discourse on the aurora borealis. His superiors gave him permission, and in 1759 Bošković set off on his travels, going first to Paris.

There he remained for six months, well received in aristocratic, scientific, and literary circles. He came to know members of the Academy of Sciences at first hand. A diplomatic intervention on behalf of his native city of Dubrovnik took him to the court at Versailles. He decided not to remain in Paris, however, and in 1760 crossed over to London, where again his reputation had preceded him among literary and scientific people. He had discussions with representatives of the Church of England; met Benjamin Franklin, who showed him electrical experiments; and visited Oxford and Cambridge. On 15 January 1761 the Royal Society elected him a fellow, and in recognition of the honor, he dedicated to it a poem on eclipses of the sun and moon. He then lent his weight to efforts to persuade the Society to organize an expedition for the purpose of observing the transit of Venus in June 1761.

Bošković had planned to make such observations himself in Istanbul but, dependent in his plans on a companion, Correr, the new Venetian ambassador to Istanbul, Bošković arrived too late for observation. He made a trip through Flanders, Holland, the court of Stanislas in Nancy, and various centers in Germany. Once in Istanbul, he fell dangerously ill and had to remain there for seven months of recuperation. Partially recovered he set off again, this time in the company of the British ambassador, and traveled through Bulgaria and Moldavia, and went on alone from there to Poland. In Warsaw he was received in ecclesiastical and diplomatic circles. The Czartoryski and the Poniatowski connections took him up. His *Diary* of the trips he made through Bulgaria and Moldavia amounts to a systematic description of the country. It was published in Italian in 1784, having already been translated into French and German. From Poland, finally, he returned to Rome—by way of Silesia, Austria, and Venice—arriving there in November 1763 after an absence of over four years which marked a stage in his life.

Back in Italy, Bošković found a situation in Pavia, where at the end of the year he won election as professor of mathematics at the university, revived under Austrian administration. He organized both his own lectures and his department realistically, with an emphasis upon applied mathematics. At Pavia he concentrated his own efforts mainly in the field of optics and the improvement of telescopic lenses, and played a leading role in the organization of the Jesuit observatory at Brera near Milan in 1764. Had his program been carried out and the instruments he advocated installed, the observatory would have been one of the most elaborate in Europe. Remembering his interest in the transits of Venus, the Royal Society invited him to lead an expedition to California for the purpose of observing the second of the famous pair of transits, that of 1769. Unfortunately political conditions prevented that trip. In 1770 he moved his work to the department of optics and astronomy at the Scuole Palatine in Milan. As time went on, he provoked opposition among his colleagues at the observatory. In 1772 the court in Vienna yielded to the demands of the majority and relieved Bošković of "concern" for the observatory. In despair he resigned his professorship also. All his world was dissolving: the next year, 1773, the pope suppressed the Jesuit order.

By now Bošković was in his sixty-third year. Influential friends urged him to repair to Paris. There a post was arranged for him as director of optics for the navy, and he even became a subject of the French crown. In Paris during this, the last productive period of his life, he worked mainly on problems of optics and astronomy. It may be that his nature was a little contentious, for there too disputes attended him, one with the young Laplace over Bošković's early method (1746) of determining the path of a comet, another with the Abbé Alexis de Rochon over priorities in the invention of a type of micrometer and megameter consisting of pairs of rotating prisms. The device became important in the design of geodetic telemeters. In search of health and tranquillity, Bošković spent the greater part of each year in the country residing at the estates of one or another of his friends.

In 1782 Bošković received leave to return again to Italy in order to ready his French and Latin manuscripts for the press. He settled in Bassano, and there in 1785 the printing firm of the brothers Remondini brought out his five-volume *Opera*. The preparation of those writings and the strain of proofreading told on Bošković's health. Once again he set out to travel, although only in Italy, in order to visit old friends. He found a cordial welcome in Milan, where former opponents were inclined to let bygones be bygones, and settled down in the Brera observatory, which he had founded, to work on the notes for the third volume of Benedict Stay's poem *Philosophiae recentioris versibus traditae libri X*, on Newtonian natural philosophy. His mental powers were leaving him, however. Forgetfulness, anxiety, fear for his scientific reputation grew upon him, and it was clear that his mind was failing. He mercifully died of a lung ailment before the decline reached an extreme and was buried in the church of Santa Maria Podone in Milan, where, however, all trace of his tomb has been lost.

Bošković's interests were more manifold than was at all normal, even in the eighteenth century, for one who participated deeply in the actual work of science. For purposes of clarity, they may be grouped under the headings of the instrumental sciences of astronomy, optics, and geodesy, and the abstract subjects of mathematics, mechanics, and natural philosophy. It must be appreciated, however, that such a classification is a mere convenience. Bošković's work in the former trio exhibited a consistent penchant for the invention or improvement of instruments of observation as well as for recognition and compensation of procedural errors. In the second, theoretical set of sciences, his writings develop a highly individual point of view. All his work, finally, may be read as physical essays in the working out of an epistemology and metaphysic that styled his career in a way, again, not at all characteristic of his century.

Instrumental Sciences. Bošković's earliest (1736) publication was a description of methods for the determination of the elements of the rotation of the sun on its axis from three observations of a single sunspot. In 1737 there followed an exposition of a graphical method for the resolution on a plane of problems in spherical trigonometry and the treatment of an actual problem in the transit of Mercury. In 1739, two years after the treatise on the aurora borealis, Bošković published an account of the principle of the circular micrometer based on the idea that the circular aperture of the objective may serve for determination of the times at which a celestial body enters and leaves the field of vision of a telescope; these values, when compared with those of a known star, give the relative positions of the two bodies.

From these specific matters, Bošković turned his attention in astronomy to a comprehensive survey of the theoretical foundations and instrumental practice and resources of practical, observational astronomy, and in the years 1742 through 1744 he published a series of works that deal with these matters in a spirit of *severioris critices leges.*

Thereafter, Bošković took up the study of comets. A widely read work of 1746 offered his opinions on a number of questions concerning the nature of comets. In it he proposed his first method—that much later criticized adversely by Laplace—for the determination of parabolic orbits. The procedure was essentially similar to that afterward introduced by J. H. Lambert (1761). Bošković's method, developed in Volume III of his *Opera pertinenta ad opticam et astronomiam* (1785), comes close to the classic method of H. W. Olbers (1797). An interesting treatise of 1749 concerns the determination of an elliptical orbit by means of a construction previously employed for resolving the reflection of a light ray from a spherical mirror. Bošković employed this method again in 1756, in a treatise discussing the reciprocal perturbations of Jupiter and Saturn, which he entered in a competition on the subject set by the Academy of Sciences in Paris. The winner was Leonhard Euler; Bošković received an honorable mention.

Bošković's interest in optics seems to have developed in the first instance out of his astronomical concerns. As early as 1747 he was discussing the tenuity, or rarity, of sunlight, apparently with the old question in mind of the hypothetical materiality of light, and at the same time attempted to estimate the density of a solar atmosphere, supposing it to reach as far as the earth. Having reflected on the problems of light, Bošković published in 1748 a treatise (in two parts) of a broadly critical nature. The central Newtonian positions in optics did not at all appear to him to be securely established. It is perhaps the most interesting feature of his critical attitude that he regarded rectilinear propagation as an unproved hypothesis, a question on which he dwelt in detail. Some other aspects of optical phenomena he thought hidden or unclear even after Newton's discoveries. Discussing phenomena of parallax, he drew attention to the distance of fixed stars in dimensions of light-years. He formulated, and was the first to do so, a general photometric law of illumination and enounced the law of emission of light known under Lambert's name. He was critical of Newton's account of colors arising from the passage of light through thin plates involving the ether and periodicity, and he provided an alternative interpretation in the spirit of his own theory of natural forces, of which more below.

In his later years at Pavia and at the observatory in Brera, he concentrated his attention on the improvement of lenses and optical devices. A series of five discourses on dioptrics (1767) treats of achromatic lenses and offers an impressive example of Bošković's experimental dexterity and accuracy, most notably in respect of measurements of the reflection and dispersion of light by means of his vitrometer. Having confirmed that two-lens arrangements will recombine only two spectral colors, he recommended a composition involving three or more lenses. He also stressed the importance of the eyepiece in achromatic telescopes. In the actual fabrication of lenses he worked with Stephen Conti of Lucca, who manufactured them according to his specifications and assisted in performing the optical experiments.

At Brera he worked intensively on methods for verifying and rectifying astronomical instruments and improved or invented a number of them, of which accounts later appeared in Volume IV of his *Opera.* Perhaps the most ingenious were a leveler that determined the plane of the edge of a quadrant and a micrometric wedge. To ensure that the border of an astronomical quadrant would be on the same level as the plane passing through the center, Bošković made use of a sort of surveying device. In a canal filled with water leading around the border of the quadrant and along one of its radii floated a small boat with a wire mast hooked at the top. Its point nearly touched the border of the instrument, permitting the measurement of small distances between the point and the water level, thus revealing the true form of the so-called plane of the quadrant. Bošković's micrometric wedge is a metallic wedge truncated on the thin side, which he used to measure the distance between two planes by inserting it into the opening between them and noting the corresponding number on the scale engraved on its side. He also thought that it ought to be possible to decide between Newton's emission theory of light and the wave theory by observations of aberration of light from the fixed stars, first through an ordinary telescope and then through a telescope filled with water. It was his further prediction that observation would detect an aberration of light from terrestrial sources: in these matters research in the nineteenth century failed to confirm his expectations.

Bošković's work in meteorology and geophysics was closely related to astronomical concerns. In 1753 he advanced the idea that the moon was probably enveloped not by an atmosphere like that of the earth, but rather by a concentric layer of some homogeneous, extremely transparent fluid. As to our own atmosphere and its behavior, or misbehavior, he investigated a tornado that devastated Rome in June 1749 and attempted to interpret its effects in terms of Stephen Hales's theory of "fixed air"—it was ever his way to try connecting phenomena in one domain with famous developments in the science of another; his mind ranged over the whole of physical science with more or less cogency, but never without imagination.

It was his idea that mountains had originated from the undulation of rock strata under the influence of subterranean fires, and developing this notion in 1742 led him to the concept of compensation of strata, which could be taken as basis of the later theory of isostasy. He also conceived the idea of a kind of gravimeter for measuring gravitation even in the ocean. At the same time, he proposed a method for determining the mean density of the earth by measuring the incremental attraction of masses of water at high tide by the deviation of a pendulum situated in the proximity.

Early in his career his interest was drawn to the problem of the size and shape of the earth, an issue intensively discussed in the first half of the eighteenth century, since its resolution was thought to be crucial in an eventual choice between a Cartesian cosmology of vortices, which predicted an earth slightly elongated at the poles, and a Newtonian one of inertial motion under attractive forces, in which case the globe should be slightly flattened. In 1739 Bošković initiated a critical investigation of existing measurements of the length of a degree along the meridian. It appeared to him that in addition to cosmological effects, superficial inequalities and irregularities of structure and density beneath the surface might well affect and distort measurements of distance along a meridian, modify the length of the second pendulum at a given locality, and bias the apparent direction of the vertical.

Bošković always promoted international cooperation in geodesy. On his initiative, meridians were measured in Austria, Piedmont, and Pennsylvania, and he himself readily collaborated with an English colleague, Christopher Maire, rector of the English Jesuit College in Rome, in surveying the length of two degrees of the meridian between Rome and Rimini. The onerous work took three years. Its results confirmed, among other things, the geodetic consequences of unevenness in the earth's strata, the possibility of determining surface irregularities by such measurements, as well as the deviation of meridians and parallels from a properly spherical shape. The report on these measurements came out in Rome at the end of 1755. Bošković employed novel methods for measuring the base line in his surveys, and he developed an exact theory of errors and learned to employ his instruments to the most accurate effect. The earliest device for verifying the points of division on the edge of such an instrument originated with Bošković, who determined from the inequalities of their chords that the circular arcs on the border of the instrument, although theoretically equal, were not in fact so. Having determined errors of division corresponding to 60° by comparing the chord with the radius of the instrument, he proceeded by bisecting to angles of 30°, 15°, and finally 5°. The method of compensating errors being applicable to astronomical as well as geodetic observations, he took an important step toward the newer practical astronomy, which for most astronomers begins with Friedrich Bessel. In the French edition of his report on measurements of the meridian, Bošković included the first theory of the combination of observations based on a minimum principle for determining their most suitable values, making use of absolute values instead of their squares, as Gauss later did in his classical method of least squares.

Abstract Sciences. Science in general took its lead in physics from Newton and in mathematical analysis from Leibniz, and it was at the root of Bošković's idiosyncrasy that, whether deliberately or not, he took the opposite tack in both respects. Mathematics had always attracted him. Instead of the calculus as developed by the great analysts among his own contemporaries—d'Alembert, the Bernoullis, and Euler—he preferred the geometric method of infinitely small magnitudes "which Newton almost always used," as he said, and which embodied the "power of geometry." He particularly applied it to problems of differential geometry, terrestrial and celestial mechanics, and practical astronomy. In 1740 he studied the properties of osculatory circles, and in 1741 devoted an entire treatise to the nature of the infinitely great and small magnitudes employed in that method. He relied upon it also in a few problems of classical mechanics: in 1740 he studied the motion of a material point and in 1743 was the first to solve the problem of the body of greatest attraction.

In mechanics (as in optics), however, his allegiance to Newton was qualified. True, he annotated Stay's elegant Latin verses on Newtonian natural philosophy, the *Philosophiae,* published in Rome in three volumes, the first in 1755. Nevertheless, his heterodoxy in mechanics began to be apparent at least as early as 1745, when he published an important discourse on the subject of living force (*vis viva*). He there put forward the view that the speed of a movement is to be computed from the *actio momentanea* of the force that generates it. Attacking the problem of the generation (*generatio*) of velocity in a new way, by distinguishing between actual and potential velocity and by introducing subtle conceptions in connection with the notion of force, he reduced the famous debate over the true measure of force, whether it be momentum (mv) or *vis viva* (mv^2), to the status of a mere argument "over titles." This discourse contained the first statement of Bošković's universal force law.

That law was inspired partly by Leibniz' law of continuity and partly by the famous thirty-first query with which Newton concluded the fourth and final edition of his *Opticks.* There Newton raised speculatively the question whether there might not exist both attractive and repulsive forces alternately operative between the particles of matter. From this idea Bošković proceeded by way of an analysis of collision of bodies to the enunciation of a "universal law of forces" between elements of matter, the force being alternately attractive or repulsive, depending upon the distance by which they are separated. As that distance diminishes toward zero, repulsion predominates and grows infinite so as to render direct contact between particles impossible. A fundamental role is played by the points of equilibrium between the attractive and repulsive forces. Bošković called such points "boundaries" (*limes,* the Latin singular). Some of them are points of stable equilibrium for the particles in them and others are points of unstable equilibrium. The behavior of these boundaries and the areas between them enabled Bošković to interpret cohesion, impenetrability, extension, and many physical and chemical properties of matter, including its emission of light.

It was because of its consequences for the constitution of matter that the law of forces was particularly important. In Bošković's natural philosophy the "first elements" of matter became mere points—real, homogeneous, simple, indivisible, without extension, and distinguished from geometric points only by their possession of inertia and their mutual interaction. Extended matter then becomes the dynamic configuration of a finite number of centers of interaction. Many historians have seen in Bošković's derivation of matter from forces an anticipation of the concept of the field, an anticipation still more clearly formulated very much later by Faraday in 1844. Matter, then, is not a continuum, but a discontinuum. Mass is the number of points in the volume, and drops out of consideration as an independent entity. In the special case of high-speed particles, Bošković even envisaged the penetrability of matter.

The principle of inertia itself did not escape his criticism. It was impossible in his view to prove it or indeed to prove any metaphysical principle to be true of physical reality a priori. But neither could it be proved a posteriori as Newtonians were wont to do from "the phenomenon of movement." Bošković emphasized the necessity of defining the space to which the principle relates. Since he held it to be impossible to distinguish absolute from relative motion by direct observation and without invoking "unproven physical hypotheses," he introduced the notion that inertia as it is observed is relative to a space chosen to include all the bodies in the universe that are within range of our senses, i.e., all the subjects of all our experiments and observations. The translation of that space as a whole can have no effect on the motion of a body within it, on its rotation at a given angle, or on its contraction or dilation if there is a simultaneous and equivalent contraction or dilation of the scale of forces. From these considerations Bošković concluded that experiment and observation could never decide whether inertia is relative or absolute.

It must not be supposed, however, that his natural philosophy represents a reversion to a Leibnizian metaphysic. He was in fact as skeptical and critical of the principle of sufficient reason or final causes as of that of inertia. In general Bošković was convinced that we know nothing so far as the absolute is concerned and just as little of what is relative. He often emphasized the impotence of the human mind, and spoke more than once of the imaginability of beings with a geometry different from ours. He had a clear understanding of the hypothetical-deductive nature of geometry, especially of the Euclidean fifth postulate about parallels. In his view our universe is no more than a grain of sand in a horde of other universes. There might well be other spaces quite unconnected to our own and other times that run some different course.

Sharp in thought, bold in spirit, independent in judgment, zealous to be exact, Bošković was a man of eighteenth-century European science in some respects and far ahead of his time in others. Among his works are writings that still repay study, and not only from a historical point of view.

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The literature on Bošković in Yugoslavia is abundant. On the occasion of the centenary of his death, the Yugoslav Academy of Arts and Sciences in Zagreb issued a collection of works on Bošković in its publication *Rad,* **87, 88,** and **90** (1887–1888), including his correspondence from the archives of the observatory at Brera as transcribed by G. V. Schiaparelli. The latter correspondence was reprinted in *Publicazioni del R. Osservatorio astronomico di Milano–Merate,* n.s. no. 2 (1938). *Gradja za život i rad Rudjera Boškovića* ("Material Concerning the Life and Work of Rudjer Bošković"), 2 vols. (Zagreb, 1950–1957), is a separate publication of the Yugoslav Academy of Arts and Sciences.

Other publications on Bošković in languages other than Serbo-Croatian are in *Actes du symposium international R. J. Bošković 1958* (Belgrade–Zagreb–Ljubljana, 1959); *Actes du symposium international R. J. Bošković 1961* (Belgrade–Zagreb–Ljubljana, 1962); and *Atti del convegno internazionale celebrativo del 250° anniversario della nascita di R. G. Boscovich e del 200° anniversario della fondazione dell' Osservatorio di Brera* (Milan, 1963).

Studies on Bošković have made considerable advances in Yugoslavia, as shown by the works of V. Varićak, in the Yugoslav Academy's *Rad;* B. Truhelka, in various reviews, based on unpublished material on Bošković, especially correspondence with his brothers; S. Hondl, in *Almanah Bošković* ("The Bošković Almanac") of the Croatian Society of Natural Science; J. Majcen; Ž. Marković; Ž. Dadić; D. M. Grmek; and others. Mention should also be made of D. Nedeljković's numerous articles in reviews, as well as in the publications of the Serbian Academy of Arts and Sciences in Belgrade; and of the works of S. Ristić, D. Nikolić, and others. A comprehensive general bibliography up to 1956 can be found in "Bošković," in *Enciklopedija Jugoslavije* ("The Encyclopedia of Yugoslavia"), II (Zagreb, 1956).

ŽELJKO MARKOVIĆ

BOSS, LEWIS (*b.* Providence, Rhode Island, 26 October 1846; *d.* Albany, New York, 5 October 1912), *positional astronomy.*

Boss, who was honored by the Royal Astronomical Society for his "long-term work on the positions and proper motions of fundamental stars," had little, if any, academic training for this work. As a student at Dartmouth College he followed a classical course, but also frequented the observatory, where he learned to handle astronomical instruments and to reduce observations. After graduation he worked as a clerk in various government offices in Washington, D.C., and frequented the U.S. Naval Observatory, from which he borrowed small astronomical instruments.

In 1872 Boss was appointed assistant astronomer for the survey of the 49th parallel, between the United States and Canada; his job during the next four years was to locate, by celestial observations, latitude stations from which the surveyors could work. His observations with a zenith telescope led him to realize that latitude determinations can be no more accurate than the stellar declinations on which they are based. Therefore, while the survey was still in progress, Boss developed a homogeneous system of declinations, as free as possible from systematic errors resulting from faulty observations and methods of reduction. From a comparison of numerous star catalogs he devised tables for the systematic correction of each, as well as a new catalog of the declinations and proper motions of 500 stars, which was adopted by the American Ephemeris in 1883.

In 1876 Boss became director of the Dudley Observatory, a position he held for the rest of his life. His first major project at Albany, New York, was observation and reduction of a zone for Leipzig's Astronomische Gesellschaft. By determining his magnitude equation and investigating the flexure of, and division corrections needed by, each of the two circles of the Pistor and Martins meridian circle, Boss was able to keep his probable errors to less than $\pm 0''.6$ for each observation—well within the limits expected for the society's catalog. Although he had little assistance, and started ten years after the work on many other zones was begun, Boss was the first to finish his zone. A comparison of the zone results with earlier observa-