it to the elementary cell in the phase space. That is, he assumed that the motion of a material system is such that we may divide its phase space into elementary cells of equal probability, whose extension is

$$h = \frac{1}{j} \sum_{i=1}^{j} \int q_i \, dp_i.$$

He utilized this assumption in discussing the spectra of hydrogen and helium and also the spectra of characteristic X rays.

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TETU HIROSIGE

ISIDORE OF SEVILLE (*b.* Spain [?], *ca.* 560; *d.* Seville, Spain, 4 April 636), *dissemination of knowledge.*

An encyclopedist, confessor-bishop, and Doctor of the Church, Isidore was educated by his elder brother Leander (a friend of Gregory the Great) and in monastery schools. He succeeded Leander as bishop of Seville and Catholic primate of Spain in 599. Much concerned with the reformation of church discipline and with the establishment of schools, he exerted an influence on science entirely through writings intended as textbooks.

Isidore wrote extensively on Scripture, canon law, systematic theology, liturgy, general and Spanish history, and ascetics. His scientific writings are chiefly to be found as parts of the glossary *Libri duo differentiarum* (*De differentiis verborum*, and *De differentiis rerum*), two short works on cosmology (*De natura rerum* and *De ordine creaturarum*) and his great encyclopedic dictionary, the *Etymologiae* or *Origines*. This last work briefly defines or discusses terms drawn from all aspects of human knowledge and is based ultimately on late Latin compendia and gloss collections. The books of greatest scientific interest deal with mathematics, astronomy, medicine, human anatomy, zoology, geography, meteorology, geology, mineralogy, botany, and agriculture. Isidore's work is entirely derivative—he wrote nothing original, performed no experiments, made no new observations or reinterpretations, and discovered nothing—but his influence in the Middle Ages and Renaissance was great, and he remains an interesting and often authoritative source for Latin lexicography, particularly in technical, scientific, and nonliterary fields.

His sources seem to have included, apart from Scripture, the Servian Vergil commentaries, gloss collections, grammars, cookbooks, and technical manuals, Ambrose, Augustine, Boethius, an abridgment of Caelius Aurelianus, Cassiodorus, Cassius Felix, Cicero, some form of Dioscorides, Donatus, a Latin digest of Galen, Gargilius Martialis, Gregory the Great, Hegesippus, Horace, Hyginus, Jerome, Lactantius, Lucan, Lucretius, Macrobius, Orosius, Ovid, Palladius, Placidus, Pliny the Younger, Pseudo-Clement, Sallust, Seneca, Solinus, Suetonius, Tertullian, Varro, Vergil, Verrius Flaccus, Victorinus, and doubtless other writers at first or second hand.

Isidore's universe was composed of a primordial substance which, by itself, possessed neither quality nor form but was given shape by four elemental qualities: coldness, dryness, wetness, and hotness. Isidore followed Lucretius and many Greek cosmographers in regarding these elements as in constant flux between the earth and the solar fire at the center of the universe. Although all elemental qualities are present in all created things, the elemental name assigned in any specific case depends upon those qualities which are most prominent. Isidore shared the microcosmic theory which views each individual human being as a microcosm paralleling the macrocosm, on a smaller scale, and regards man as the central link in this chain of being. The elements shade into each other and are arranged in the solar system by weight, each stratum of the concentric spheres having its proper inhabitants: angels in the fiery heavens, birds in the air, fish in the water, and man and animals on solid earth.

Isidore summarizes this view in the *Etymologiae*, (13.3.1–3; see also his *De natura rerum*, 11.1):

> *Hylê* is the Greek word for a certain primary material of things, directly formed in no shape but capable of all bodily forms, from which these visible elements are shaped, and it is from this derivation that they get their name. This *hylê* the Latins call "matter," because being altogether formless from which anything is to be made, it is always termed "matter." . . . The Greeks, however, have named the elements *stoicheia*, because they come together by a certain commingling and concordance of association. They are thus said to be joined among

themselves by a certain natural ratio, so that something originating in the form of fire returns again to earth, and from earth to fire just as, for example, fire ends in air, air is condensed into water, water thickens into earth, and earth again is dissolved into water, water evaporates into air, air is reduced into fire. . . [Sharpe, *Isidore of Seville: The Medical Writings*, p. 23].

The same distribution of elements occurs in the human body: blood, like air, is hot and moist; yellow bile, like fire, hot and dry; black bile, like earth, cold and dry; and phlegm, like water, is cold and wet. Individual temperaments are determined by the dominant humoral qualities, and health depends upon their balance. Disease arises from excess or defect among them: acute diseases from the hot, and chronic diseases from the cold elemental humors. Therapy attempts to restore their normal balance. The living organism is governed by the soul but animated by the *pneuma*, which is assigned various names as it assumes various functions within the organism. Isidore rejects the pantheistic notion that the individual soul is either part of or indistinguishable from the world *pneuma*. His psychology follows late classical views of cerebral localization of function (sensation anteriorly, memory centrally, and thought posteriorly) and of the traditional faculties of the soul: intellect, will, memory, reason, judgment, sensation, and the like. The soul is distinct both from the mind and from the vital spirit; sensation and thought are distinguished, as are illusion and error.

Western Europe in Isidore's time had little direct contact with the Greek scientific tradition and derived both science and philosophy at second hand. The bulk of early Latin scientific writing was severely practical or anecdotal and descriptive. Most of Isidore's scientific passages merely define words or phrases. A man of his time, Isidore was more concerned with analogy than with analysis, with the unusual than with the typical. An encyclopedic dictionary is too disconnected to present a scientific world view; but Isidore carefully and quite accurately preserved much of the scientific lore current late in the Roman period, when original work had long since ceased and facility in Greek had perished. If he was no Aristotle, he was a great improvement on Pliny, and—considerations of style apart—his scientific content compares very favorably with that of Lucretius.

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William D. Sharpe

ISIDORUS OF MILETUS (*b.* Miletus; *fl.* Constantinople, sixth century), *architecture, mathematics.*

Isidorus of Miletus was associated with Anthemius of Tralles (a neighboring town of Asia Minor) in the construction of the church of Hagia Sophia at Constantinople. The church begun by Constantine was destroyed in the Nika sedition on 15 January 532.[1] Justinian immediately ordered a new church to be built on the same site, and it was begun the next month.[2] Procopius names Anthemius as the man who organized the tasks of the workmen and made models of the future construction, adding: "With him was associated another architect, Isidorus by name, a Milesian by birth, an intelligent man and in other ways also worthy to execute Justinian's designs."[3] Paul the Silentiary concurs in his labored hexameters: "Anthemius, a man of great ingenuity and with him Isidorus of the all-wise mind—for these two, serving the wills of lords intent on beauty, built the mighty church."[4] It is commonly held that Anthemius died in or about 534,[5] when Isidorus was left in sole charge, but this must be regarded as unproved. The church was dedicated on 27 December 537.[6]

In the astonishing space of five years Anthemius and Isidorus erected one of the largest, most ingenious, and most beautiful buildings of all time. The ground plan is a rectangle measuring seventy-seven by seventy-one meters, but the interior presents the appearance of a basilica terminating in an apse, flanked by aisles and galleries, and surmounted by a dome greater than any ecclesiastical dome ever built. The dome rests upon four great arches springing from four huge piers; the pendentives between the arches were at that time a novel device. As in the church of SS. Sergius and Bacchus in the same city,