

Abraham ibn Ezra

During the last thirty or so years of his life, Rabbi **Abraham-ben-Méir ibn Ezra** (1092 – 1167) was a restless, nearly destitute wanderer. Little is known of his life except that he is revered as the most learned Jewish scholar of his time. Born and educated in Toledo during the “Golden Age” of Muslim Spain, he died on a journey from Rome to his native land. Tradition has it that ibn Ezra married the daughter of his friend and prominent scholar Judah HaLevi. After three of his children died and his son Isaac converted to Islam, a severe blow, ibn Ezra went into



a period of self-exile, perhaps to locate his son and bring him back to Judaism. He traveled to North Africa, Egypt, Italy, France, and England, staying for extended periods in some of these places, where he wrote many of his brilliant works. He wrote more than 100 books on medicine, astronomy, astrology, mathematics, philosophy, poetry, linguistics, and commentaries on the Bible and the Talmud. He was a poet, philosopher, biblical exegete, mathematician, astrologer, translator and grammarian. Through his wanderings ibn Ezra helped propagate the rationalistic and scientific points of view developed in Spain by Muslims and Jews among the Jewish communities of Christian Europe. He translated an astronomical work from Arabic into Hebrew, creating a Hebrew prose style for scientific purposes. His works showed a strange mixture of rationalism and mysticism, with a deep interest in magic squares and the mystical properties of numbers. He was the inspiration for Robert Browning’s poem “Rabbi Ben Ezra,” which begins with the familiar line “Grow old along with me! The best is yet to be...”

His travels during the period 1140 to 1160 took him from London in the north to Egypt in the east with stops along the way in Rome, Salerno, Verona, Lucca, Béziers, and Narbonne to mention but a few. At

each stop, like a linguistic and scientific Johnny Appleseed, he spread knowledge of Arabic learning in Christian Europe where scholarship had been in a deep slumber for some 500 years. His Hebrew translation of al-Biruni's work on the astronomical tables of al-Khwarizmi (only known through Ibn Ezra's version) was the authoritative astronomical guide for Roger Bacon, Nicholas of Cusa, and Pico della Mirandola. In *Book of the World* he cautioned that all astronomical tables predicting the times of planetary conjunctions were erroneous because they assumed uniform motion of the planets. He claimed that through time, there had come to be an accumulation of errors and it was unreasonable to extrapolate from ancient data. He relied only on astronomical observations made by contemporary "sages."

Ibn Ezra wrote three treatises on numbers, *Book of Unity*, *Book of Number*, and the . In the *Book of Unity*, he used the Indian symbols 1, 2, 3, 4, 5, 6, 7, 8, 9. In the *Book of Number*, he described a positional decimal system for integers with place values, reading from left to right. Although based on the Hindu arithmetic he used Hebrew letters $\aleph, \beth, \gamma, \delta, \epsilon, \zeta, \eta, \theta, \iota$, and κ for the numerals 1 - 9, and a zero that he called *galgal*, meaning a wheel or a circle. To illustrate the magical properties of the positional decimal system he discussed the evaluation of the ratio of the circumference of a circle to its diameter, [not yet denoted by the symbol π], whose value he gave as 3.142, thusly:

"And when you add the square of 1 to the square of the first [non one] odd number, ..., and then you draw a circle with the former as diameter, and then draw a perpendicular [chord] at [a distance of a] third [from the end], the isosceles triangle that is formed [whose base is the chord and whose height is the longer segment of the diameter] has an area equal to the perimeter of the circle."

The *Ta'hbula* contained "The Josephus Problem," of which there are many versions; with the goal of

ensuring those who are “good” survive a mass suicide or slaughter and the “evil” do not. Depending on when and by whom the problem is related, the good and the evil can be any group and those they consider enemies. The original version is the legendary story of famous Jewish historian Josephus Flavius who finds himself and 40 other Jews trapped in a cave at the fortress of Masada surrounded by Roman soldiers. Rather than surrender they plan to kill themselves. Josephus isn’t keen on the idea and comes up with a mathematical plan to save himself. Everyone is arranged in a circle and all agree that each third person, counting around and around, should be killed. Wisely Josephus places himself and a friend in the 16th and the 31st position of the circle of 41. In this arrangement, these two are the last alive after the counting and killing is concluded, and Josephus convinces his companion to avoid martyrdom.

A strictly mathematical version of the problem is to consider a group of n people standing in a circle, numbered consecutively clockwise from 1 to n . Starting with person number 2, and moving clockwise, every other person is removed, until only one remains. For instance, if $n = 10$, the people are arranged around a circle in the order ABCDEFGHIJ. They are removed in the order B, D, F, H, J, C, G, A and I with E the last remaining. In general, the problem is to find some simple way to compute $J(n)$, which represents the last person remaining in the case of n people arranged in a circle. The solution of the problem can be obtained using binary digits, as each person in the circle, as they are counting around, will be removed or allowed to remain. The problem can be modified by changing the beginning point and the number of places moved counterclockwise before removing someone.

Ibn Ezra’s most famous works were his commentary on the Bible and the Torah. Scholars suspect that he didn’t believe that Moses wrote the Torah, finding clues that it had been written over a period of time. He couldn’t publicly proclaim this belief, for it would have meant his death. Whenever he treads upon controversial ground he carefully prefaced his remarks with the phrase, “And the intelligent will

understand.” Ibn Ezra suggested that the form and matter of the intelligible world emanated from God, whereas the terrestrial was pre-existent and uncreated.

Quotation of the Day: “ Known that every calculation that adds from one to any number that one wills, you can obtain by its value [multiplied] by its half together with half of one...we can start to know how many combinations [involving] two servants [he called planets “servants, perhaps servants of God]. And it is known that the number of servants is seven. And Saturn can combine with six other servants. And six by its half and the half of one is one and twenty. And thus is the number of combinations of twos. Now we wanted to know the number of combinations of threes. Here we put Saturn and Jupiter and one of the others, their number is five. We multiply five by two and a half and a half, and get fifteen.... – Abraham Ibn Ezra