Rabbi Levi

Baruch Sterman

On a clear night when the full moon shines, one can look up and make out the dark patches – called mare or "seas" by the first observers who thought that the dim smooth areas were water. With binoculars or a small telescope, the craters can be seen. They are named for great scientists and mathematicians whose work helped our knowledge of astronomy progress. Bright Tycho and the impact rays emanating from it is the most pronounced, and nearby is Copernicus, whose light rays stand out against the mare which surround it. Down in the shadowy crater field towards the bottom of the moon, at latitude 34.7S, longitude 23.6E, one can find a crater approximately 81 km in diameter named "Rabbi Levi." How did a nice Jewish boy end up in a place like that?

The namesake of that crater is Rabbi Levi Ben Gerson (1288–1344), known by his acronym RaLBaG, by his full name, Meister Leo de Bagnols, or by the Latin, Gersonides. He is best remembered today for his commentary on the Bible, which is printed in the margin of the popular *Mikraot Gedolot* series on the books of the Prophets. His *magnum opus* was the philosophical work called *Wars of the Lord*, in which he boldly put forth his theories on fundamental theological issues such as the doctrine of choice (free will) and providence, God's knowledge, and creation. Whereas his predecessor, Maimonides, had been particularly ambiguous about such matters, Ralbag makes his (often controversial) opinion clear and unequivocal, to the point where many later Jewish philosophers were harshly critical of his views. (Ibn Shem Tov pejoratively terms Ralbag's book *Wars against the Lord*!)

In addition to his accomplishments in the Jewish arena, as a philosopher, Talmudist, and Biblical exegete, Rabbi Levi was also an expert logician, mathematician, physician, and astronomer. He wrote commentaries on many of the philosophical works of Aristotle and Averroes. He composed three major books on mathematics (in addition to his commentary on some of Euclid's books, and sine tables accurate to the fifth decimal); the first on general mathematics both theoretical and practical, the second on harmonics, and the third book (which he dedicated to Pope Clement VI) on trigonometry. Some claim that he was the first to use the important method of mathematical induction (e.g., if some property is true for 1 and the truth of that property for n implies its truth for $n+1$, then that property will be true for every natural number), which he called *hadragah* or rising step by step.

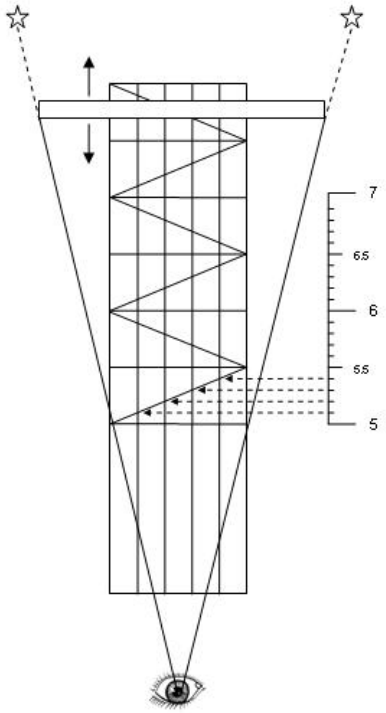
In terms of astronomy, he presented a novel planetary model and compiled precise astronomical tables. Ralbag demonstrated that Ptolmey's geocentric model predicted results which did not accord with observation, thus setting the foundations for the revolution that would eventually lead to Copernicus' heliocentric model. While the regnant opinion was to put the stars at a distance of a few tens of thousands of kilometers, Levi put them ten billion times farther – about 10-100 light years in modern parlance – close to our current notions, but remarkably unique in terms of medieval thinking. In an age where dogma ruled, Ralbag was the consummate empiricist; he mistrusted all previous data and relied only on his own observations. Levi writes:

> No argument can nullify the reality that is perceived by the senses, for true opinion must follow reality, but reality need not conform to opinion.

But Levi's greatest contribution to the field of astronomy was his invention of an instrument for precise determination of the angular separation between two stars. He called it the *Megalleh Amuqot*, (Revealer of Profundities), but the popular name was *baculus Jacobi*, Jacob's Staff.

The design put forth in the fifth section of Levi's *Wars* describes a rod which slides along a length of track which is positioned directly in front of the observer's eye. By adjusting the distance of the cross rod

from the eye, one can line up the rod precisely such that edges of the rod just block the two stars being measured. It is then a matter of simple trigonometry to determine the angular separation of the two stars (or a star and the horizon, or even two terrestrial objects) from the width of the cross rod and its distance from the eye.

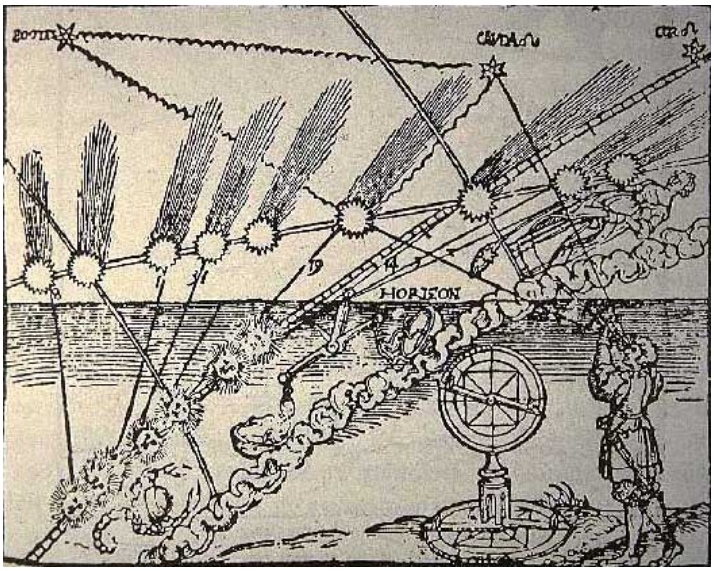


In addition to its elegant simplicity, I find three aspects of the instrument to be particularly noteworthy. First, Levi invented a unique method of marking the distance along the track, known as a transversal scale, which dramatically improved the precision of his measurements. In addition to the equidistant lines across the width of the track, Levi drew lines lengthwise as well. He then etched diagonals from the side of one unit measuring line to the opposite side of a subsequent line so that the intersection of the diagonal with the transverse rows designated a finer scale for more accurate measurement. This is shown in the accompanying diagram (based on Bernard Goldstein's translation of *Wars*).

Furthermore, Levi realized that the plane of vision was not actually the front of the eye, but somewhere behind that. The difference would have to be taken into account if the measured distance of the cross rod to the center of vision was to be accurate, and he devised a precise method of determining what was later called "the eccentricity of the eye".

These features are of a scientific and engineering nature, but there is another dimension to Levi's invention that sheds light on his fundamental worldview. It is of supreme significance that Ralbag chose to present his most important astronomical treatise as a section in his most important religious work. At a recent lecture on Torah and Science, Rabbi Adin Steinsaltz compared the relationship between the two to a rocky marriage, where the particular argument shifts from time to time against a backdrop of constant bickering. If this is a more or less accurate impression of the current situation, for Ralbag the relationship was closer to a newlywed couple dreaming of building a harmonious and loving life together. Levi believed that the ultimate function of astronomy was to understand God, and at the same time he was sure that God given reason could never be in conflict with God given Torah.

Ralbag's invention enjoyed a long and illustrious history and its use was ubiquitous for the next 300 years. The German cartographer and navigator, Martinus de Bohemia brought the Jacob's staff to Portugal and it was used both by Columbus and Magellan as a navigational tool. Copernicus, Tycho, and Kepler used the instrument extensively. Indeed, the frontispiece of Kepler's Ruldophine Tables has a drawing of the temple of Urania, the muse of Astronomy which depicts the progress of astronomy through history. Towards the top of the pillar representing Copernicus, a Jacob's staff hangs prominently.



The picture on the right shows the German astronomer Peter Apian (in 1531) using a Jacob's Staff to determine that the tail of a comet (his

particular comet was later found to be Halley's) always points away from the sun. (Coincidentally, the Hebrew word for staff or scepter (*shevet*) is related to the term for comet (*shavit*).)

"A star shall come out of Jacob, and a staff shall rise out of Israel," (Numbers 24;17) proclaims Balaam the prophet. Ralbag's staff of Jacob rose from Israel and shined brightly for hundreds of years, illuminating the paths of the stars in heaven and guiding the course of men as they sailed across the earth.

For further reading:

1. http://plato.stanford.edu/entries/gersonides/
2. A complete *Bibliographia Gersonideana* can be found at: http://hcc.haifa.ac.il/Chairs/Wolfson/bibliographia.htm
3. Bernard R. Goldstein, *The Astronomy of Levi Ben Gerson 1288-1344: A Critical Edition of Chapters 1-20*. New York: Springer Verlag, 1985

Rabbi Levi (crater)

General characteristics	
Latitude	34.7° S
Longitude	23.6° E
Diameter	81 km
Depth	3.5 km
Colongitude	336° at sunrise
Eponym	Levi Ben Gershon
References	See listing

Rabbi Levi is a lunar impact crater that is located among the rugged highlands in the southeastern part of the Moon's near side. Several notable craters are located nearby, including Zagut crater just to the north-northwest, the heavily impacted Riccius crater to the southeast, and Lindenau crater to the northeast next to Zagut.

This is a heavily worn and eroded crater formation, with several smaller craters lying along the incised rim and across the interior floor. A group of these craters form a cluster in the western part of the floor, consisting of the satellite craters A, L, M, and D, as well as lesser craterlets trailing away to the south-southeast. The largest of these craters is 'Rabbi Levi L', a bowl-shaped formation just to the northwest of the mid-point. The remainder of the floor is relatively level and nearly featureless. Clusters of craters also lay across the eastern and southwestern sections of the rim.

Attached to the northeast is the remnant of an old formation that intrudes into the Rabbi Levi crater, producing a straightened section of rim along that face. This unnamed formation has been almost completely obliterated, and is overlaid in the northwest by Lindenau, and along the outer northeast side by Rothmann crater.