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DISCOVERY OF THE LOST STAR CATALOG OF HIPPARCHUS ON THE FARNESE ATLAS

The discovery of the long lost star catalog of Hipparchus, which dates to 129 BC, has been identified as appearing on an old Roman statue called the Farnese Atlas. The findings were presented in a press conference today by Prof. Bradley E. Schaefer (Louisiana State University, Baton Rouge) at the American Astronomical Society meeting in San Diego, California. Hipparchus was the greatest astronomer of antiquity and his star catalog was the first in the world as well as the most influential, yet it was lost early in the Christian era, perhaps in the fire at the great library in Alexandria. The Farnese Atlas is a Roman statue dating to the second century AD that depicts the Titan Atlas holding a sky globe on his shoulder, with the relief figures on the globe depicting the ancient Greek constellations in fine detail. The discovery by Schaefer is that the constellation figures on the Farnese Atlas are an accurate rendition of Hipparchus' star catalog; this discovery will likely lead to the solution of several long-time debates.

Hipparchus is highly regarded for his work around 140-125 BC on the discovery of precession, the first nova, his theory for the motions of the Sun and Moon, his top quality planetary observations, as well as the all-time-first catalog of ~1000 stars. But only one of Hipparchus' books has survived to today (his *Commentaries*, which describe the constellation figures in detail) with the rest only being known by references of later astronomers, for example with his star catalog being described in Ptolemy's *Almagest*.

The Farnese Atlas is a marble statue roughly seven feet tall. It is now in the Farnese Collection in the National Archaeological Museum in Naples, Italy. The statue's sky globe, which is 26 inches in diameter, shows 41 Greek constellations plus the celestial equator, tropics, and ecliptic. Art historians conclude that the statue is a late Roman copy of a Greek original. Schaefer says that the constellations are accurately depicted, so the sculptor must have based his work on some specific astronomical observations. Throughout the last century, these original observations have been attributed to many sources, but *not* Hipparchus, stretching from 1130 BC to AD 200.

Precession, as discovered by Hipparchus, is the slow motion of the stars and constellation figures with respect to the celestial equator, tropics, and meridian lines. This provides the key to dating the original observations, Schaefer explained, because it means that investigators need only to look on the sky globe to see what date matches the constellation positions. Dr. Schaefer has made the first astronomical analysis of the globe. For his analysis, he went to Naples to take his own pictures because the photographic analysis requires the knowledge of the globe-camera distance. He measured a total of 70 positions on the globe and made a formal mathematical fit to find the best date. This best date for the original observations is 125 BC. He said that the normal margin of error in this date is ± 55 years. In other words, Schaefer said, there is a two-thirds chance that the real date was between 180 BC and 70 BC.

Schaefer said that the date of 125 BC immediately points to Hipparchus' catalog, from 129 BC, as the original observation source. Indeed, he said, *all* previously proposed

candidates are confidently eliminated. That is, Aratus around 275 BC, Eudoxus around 366 BC, and the Assyrian observer around 1130 BC are all much too early while Ptolemy around AD 128 is much too late.

The positioning of the constellation figures on the Farnese Atlas has a typical accuracy of 3.5 degrees. Schaefer says that such an accuracy is essentially impossible to be achieved by simple verbal descriptions, such as given by Aratus or Eudoxus, which are accurate to ~8 degrees. However, ancient star catalogs easily have the required accuracy. Hipparchus is known to have a star catalog of the right date, 129 BC, whereas the next catalog, created by Ptolemy, came much too late, in AD 128. Hipparchus is known to have constructed many sky globes based on his star catalog. For instance, ancient coins depict Hipparchus seated in front of a globe and Ptolemy writes explicitly of Hipparchus making such globes. Schaefer points to a likely scenario in which Hipparchus used his catalog to make an accurate globe, with this then being copied exactly by a Greek sculptor. The Greek statue was later copied by a Roman sculptor.

The constellation figures of the Farnese Atlas contain many specific details that point to Hipparchus as the original observer. Schaefer made a comparison between the Farnese Atlas and all ancient constellations descriptions, including those of Ptolemy, Hipparchus, Aratus, Eratosthenes, Eudoxus, and Homer. All ancient sources *other than* Hipparchus have many and major differences in their descriptions of the constellations. For example, Aratus places the solstices 35° off, Libra is 'the Claws' instead of the 'Balance', and the end of the 'River' is 50° different. However, the detailed comparison shows Hipparchus' *Commentary* to have zero differences and many unique similarities.

The case for Hipparchus' lost star catalog appearing on the Farnese Atlas is based on: (A) The derived date of 125 BC matches Hipparchus and rejects all other candidates. (B) The accuracy requires a star catalog and only Hipparchus had created one before AD 128. (C) Hipparchus is known to have produced working sky globes from his catalog. (D) Only Hipparchus' description of the constellation figures matches the Farnese Atlas.

Dr. E. C. Krupp, Director of the Griffith Observatory in Los Angeles says "The constellations are one of our more enduring intellectual properties, and in antiquity, they turned the night sky into familiar territory. Dr. Schaefer's clever and disciplined analysis of the oldest graphical representation of the traditional Greek constellations reveals unexpected roots of scientific astronomy in a celebrated work of ancient art."

The discovery of Hipparchus' lost star catalog on the Farnese Atlas will likely provide answers to two long-standing questions. The first question is what Hipparchus used as coordinates, with various answers being equatorial, ecliptic, mixed, or none. With the Farnese Atlas showing a clear system of circles marking the equatorial system, the equatorial answer is now likely. The second question is what fraction of Hipparchus' star catalog has made it into Ptolemy's *Almagest*? Now, with an accurate representation of Hipparchus' catalog, future workers can make exhaustive correlations between all constellation figures on the Farnese Atlas and the *Almagest*.

Schaefer concludes, "Perhaps the most fascinating part of the discovery is simply that we have recovered one of the most famous known examples of 'lost ancient wisdom'".

For more information:

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The results on the Farnese Atlas are now *in press* for the May 2005 issue of the *Journal
for the History of Astronomy* (<http://www.shpltd.co.uk/jha.html>).

Copies of the figures, journal paper, and precession movie can be downloaded
from <http://www.phys.lsu.edu/farnese/>