SHAPLEY, HUBBLE, AND COSMOLOGY

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ABSTRACT  Working for several years around 1918 at Mount Wilson Observatory, Harlow Shapley almost single-handedly delineated the vast scope of the Milky Way, but in 1921 he left California for Harvard. Edwin Hubble, who provided the primary observational foundation for the concept of the expanding universe (which is now considered the major astronomical idea of our century), spent his entire career in southern California. From opposite sides of the continent the two men sparred over the homogeneity of the observable universe.

Harlow Shapley’s seven years at Mount Wilson (1914–21) were the most productive of his research career. He wrote over 100 notes and papers (30 in the Publications of the A.S.P.), and he radically altered the concept of the Milky Way. Early in 1914 Shapley wrote to the Dutch astronomer J.C. Kapteyn that “the work goes on monotonously, but the results are a continual pleasure. Give me time enough and I shall get something out of the problem yet.” Barely a year later he was able to report to Arthur Eddington that “with startling suddenness [the cluster studies] seem to have elucidated the whole sidereal structure. . . . To be brief, the globular clusters outline the sidereal system.” Walter Baade later remarked, “I have always admired the way in which Shapley finished this whole problem in a very short time, ending up with a picture of the Galaxy that just about smashed up all the old school’s ideas about galactic dimensions.”

These researches at Pasadena, combined with Adriaan van Maanen’s measurements of the apparent rotation of spiral nebulae, led to a very different view of the universe than the one favored farther north at Lick Observatory. There, Heber D. Curtis was convinced that the spirals were island universes, but he was skeptical of Shapley’s use of cepheid variables to delineate the scale of the Milky Way. George Ellery Hale, director of the Mount Wilson Observatory and an energetic member of the National Academy of Sciences, arranged for the two astronomers to present their divergent views in Washington in April of 1920. The famous “great debate” took place near the end of both of their West Coast careers.

In 1919 Hale had added another Missourian to his staff. Edwin Hubble had been an undergraduate at the University of Chicago, and after a sojourn in Oxford studying law on a Rhodes scholarship, he eventually returned to Chicago for a doctorate in astronomy. When Hubble arrived in Pasadena, Shapley, and perhaps others, found his carefully cultivated Oxford accent a little off-putting. The tall, athletic, urbane Hubble was a study in contrasts.
with Shapley, who remained at the core a wide-eyed farm boy, and I can well imagine that Shapley may have harbored more than a twinge of jealousy for his new junior colleague.

Hale brought Hubble to Mount Wilson specifically to work on nebulae, just as Shapley’s job was to study clusters. Shapley was later sometimes criticized, by Baade among others, for not carrying the hunt for cepheids to the spirals, but in addition to the psychological barrier, it was a question of turf, and clearly from the time of his arrival, Hubble had the nebulae as his mandate. In any event, as far as the spiral nebulae were concerned, the party line at Mount Wilson was to reject the Lick astronomers’ notion that they were island universes, and this was so even after Shapley had gone east. Thus, in July of 1922 Hubble wrote to Shapley at Harvard saying that, “My own preference concerning the [star-like] objects clustering [around] M87 is to call them stars until they may be definitely shown not to be stars.” With our 20-20 hindsight we know these objects are particularly luminous globular clusters around the giant spherical galaxy M87, and to mistake them for single stars could only lead to a conclusion that the Virgo nebulae were too close to be considered as island universes.

At best the situation was quite muddled until the beginning of 1924, when Edwin Hubble wrote to Shapley that, using the 100-inch at Mt Wilson, he had found a faint cepheid variable in M31. Application of Shapley’s calibration of the period-luminosity law for cepheids then placed the spiral at nearly a million light-years. Shapley promptly responded that “Your letter telling of the . . . variable stars in the direction of the Andromeda nebula is the most entertaining piece of literature I have seen for a long time,” and he promptly capitulated to the island universe viewpoint.

This still left the problem that our Milky Way was vastly larger than the Andromeda spiral. One approach was to consider that the Milky Way and its associated system of globular clusters was actually a supergalaxy, a collection of many systems perhaps something like the great congregation in Virgo. Shapley laid the foundation for such a discussion with paper published in 1926 on the Virgo cluster. Writing jointly with Adelaide Ames, he described the cluster as a cloud of galaxies placed at ten million light-years. By 1930 Shapley suggested as a working hypothesis the notion that our “unexpectedly extensive and populous” Milky Way system was “an amalgamation of star clusters and star clouds.” His earlier insight that the Milky Way was far vaster than previously believed had set him at odds with Kapteyn, whose statistical measurements led to a much smaller sun-centered system. Shapley now proposed that our local system (which would roughly correspond to the dimensions found by Kapteyn) was similar to one of the Magellanic Clouds, and that the Scutum star cloud, the Cygnus star cloud, and perhaps half a dozen others were typical galaxies “in the sense that the average spiral nebula is a galaxy.”

Meanwhile, other developments were afoot, namely, the discovery by Hubble and his associates that the fainter the nebula, the greater its spectral red shift, a discovery that led to the concept of the expanding universe.
Shapley, lacking the large light-gathering power and spectrographic facilities of the Mount Wilson Observatory, was locked out of the game, but with the legacy of survey instruments inherited from Pickering, he could mount large scale surveys, which began to show the irregularities of galaxy distributions. The joint paper with Adelaide Ames on the Virgo cluster was a typical fruit of this approach. There they tossed out the challenge that “Much remains unknown concerning the distribution over the sky of the nebulae of the spiral family, notwithstanding the rather confident assertions and generalizations that are frequently made.” In a semi-popular series of lectures at Rice University, Shapley threw down the gauntlet: “Taking the whole sky, we find, in agreement with Hubble, that the increase of numbers with decreasing brightness is approximately of the order of magnitude appropriate to uniform density [that is, about four times more galaxies for each fainter magnitude]. But,” he continued, “for various large sections of the sky the uniformity criterion fails conspicuously.”

Hubble responded privately to Shapley, saying, “I do not place so much significance in the non-uniformity of distribution as you, for the data tend to smooth out when fainter limits are used.” Shapley countered, “I sometimes feel you have done harm by emphasizing too much the uniformity, thus leading theorists into too much optimism over their highly simplified set-ups. On the other hand, you may think I emphasize the irregularity too much. But there is a deep meaning in non-uniformity in the star distribution... These irregularities in the distribution of nebulae are highly important structural phenomena.”

In retrospect we can sympathize with Hubble’s desire for the existence of large-scale homogeneities, which made possible an initial exploration of cosmological issues. The concept of the expanding universe is undoubtedly the major astronomical idea of the twentieth century. Both theoreticians and observers helped fashion this majestic cosmic view. Even Shapley had played a part with his initial calibration of the period-luminosity law of the cepheids. Yet one name above all is linked with the expansion of the universe: Edwin Hubble’s. He is rightfully considered the prime architect of this powerful cosmological view. However, I don’t think it detracts from his enormous credit to notice that the irregular distribution of galaxies, which Shapley was beginning to delineate, today adds an important dimension to our understanding of the large-scale structure of the universe.

REFERENCES