Biography of Brenda Frye

Brenda L. Frye is a leading figure in the areas of observational Cosmology and extragalactic astronomy, and is making a concerted effort to understand how galaxies such as the Milky Way formed and evolved in this expanding universe. Currently, she is a Full Professor of Astronomy at the University of Arizona.

Attracted to challenges, Frye began her academic career by earning dual B. S. degrees in Astronomy and in Physics, *magna cum laude,* at the University of Arizona. She earned a Ph.D. in Astrophysics from University of California at Berkeley, opting to stay in California to accept a postdoctoral position at Lawrence Berkeley National Laboratory under the mentorship of Professor and Physics Nobel Laureate Saul Perlmutter. She next headed eastward to accept two awards: the National Science Foundation Astronomy & Astrophysics Postdoctoral Fellowship (AAPF), and the Council on Science & Technology Fellowship (CST), both held at Princeton University. She then ventured across the Pacific Ocean, landing in Dublin Ireland, to take on her first Professorship of Physics. She returned to California to take on a tenure-track Professorship at the University of San Francisco, before being recruited to the University of Arizona as Professor.

Frye made significant contributions to our knowledge of galaxies by a novel approach. Einstein first correctly predicted that mass bends light. The larger the mass, or “lens”, the greater the effect. A galaxy cluster serves as the largest and most powerful gravitational lens. For any galaxy situated in the background, its image is boosted in brightness and size by this lensing effect, and can even present multiple images.

Frye discovered some of the most powerful and massive gravitational lenses by her novel approach. She then extracted the distribution of the invisible dark matter in these cluster lenses, and finally used the cluster lens as a tool to analyze the magnified images of the more distant and hence younger galaxies in the background. This work elucidated our understanding of the processes that govern galaxy evolution, with implications that extended to how our own Milky Way formed.

Frye used one galaxy cluster lens to make a significant discovery. This massive lens was comprised of dozens of galaxies of 10 billion stars each plus an even more significant underlying dark matter mass component. A coincident background source unrelated to the lens consisted of another dozen young galaxies which were actively assembling new stars and suffering the inevitable byproducts of stellar explosions or “supernovae”.

One supernova that was situated at more than half the age of the universe was gravitationally lensed into three different images of itself. A more detailed analysis categorized this supernova as “Type Ia” that is of known intrinsic brightness, or a “standard candle”, thereby elevating its potential to advance scientific knowledge.

Since the light path lengths are different for each of the images and the speed of light is a constant, this meant that there was a delay in the arrival time of the light into each of the images. Frye played a pivotal role in leveraging this supernova discovery to make a measurement of the current rate of expansion of the universe. This is because a measurement of this time delay carries with it cosmological information.

Frye built an international team of researchers in order to benefit from different perspectives and analysis techniques. She accomplished this by announcing a physics challenge that was open to all, requiring only an answer to be submitted by the stated deadline. She instituted double-blinding protocols to avoid influences from other teams.

In total, contributions arrived from nine teams that spanned four continents. By assessing weights to each team’s contribution based off of the known luminosity of this standard candle, Frye and her team were able fairly to incorporate the various contributions into the final answer. In doing so, one of the most accurate and precise values for the current universal expansion rate was achieved. It is engraved in history as the first value obtained from a lensed standard candle, and it was accomplished by a world-wide effort.

The value for the expansion rate of the universe by this probe of time-delay cosmography agreed with methods at late cosmic times. At the same time, this value differed from that obtained by probes of the early universe. This “Hubble tension” has become one of the most vexing problems in Astrophysics.

If the tension persists, then it calls into question the validity of the hot “Big Bang” model that provides the currently accepted description of our universe. These studies have opened the door to a new field of Astrophysics by applying lensed standard candles to measure a global property of the universe. Notable accomplishments have been made en route to this work, such as the discovery of distant galaxies in the universe, which at times have held records for the most distant object every discovered.

In recognition of this discovery, Frye was given the honor of naming the event that enabled that rare measurement of the expansion rate of the universe, which she dubbed “SN H0pe” for the hope to deliver an answer to the Hubble tension. Frye has taught thousands of students in lecture halls and mentored >50 students earning advanced degrees on two continents.