Margaret Burbidge obituary

Astronomer who established that the Earth's chemical elements were formed inside stars

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Margaret Burbidge in Dallas, Texas, in 1964. She challenged various forms of sexism in astronomy, and was elected first female president of the American Astronomical Society. Photograph: Sky & Telescope

The British-American astronomer Margaret Burbidge, who has died aged 100, was the principal author of a watershed scientific paper in 1957 that set out the evidence for chemical elements having been formed inside stars. In essence, the work of her and her collaborators proved that the iron in our blood, the oxygen in our lungs, the calcium in our bones, even the carbon in our DNA was made in the hearts of massive stars and then exploded back into space billions of years ago.

The 100-page paper was titled Synthesis of the Elements in Stars and was published in the journal Reviews of Modern Physics. Burbidge was the first author, together with her collaborators, her husband, Geoffrey Burbidge, William A Fowler and Fred Hoyle; the paper became known as B2FH, from the first letters of its authors' surnames.

Prior to its publication there were two competing theories for the origin of the chemical elements. The Soviet-American physicist George Gamow thought they were formed during the birth of the universe, in the big bang. However, astrophysicists had shown that stars generated energy by fusing lighter elements into heavier ones. This led the British astronomer Hoyle to propose, in 1954, that the big bang only made the three lightest elements, hydrogen, helium and lithium, and that stars made all the rest. Over a two-year period, 1955-56, the Burbidges and Fowler then gathered a wealth of evidence in support of Hoyle's theory. These included astronomical observations taken by Margaret of the elemental abundances, and the laboratory measurements of nuclear reactions gathered by Fowler.

The results were conclusive. The paper changed our understanding of cosmic evolution, and of our connection to the vast universe. As Fowler put it: “All of us are truly and literally a little bit of stardust.”

Margaret and Geoffrey Burbidge at Caltech, the California Institute of Technology in Pasadena, in 1956. Photograph: Caltech Archives

Born in Stockport, Greater Manchester, to Stanley Peachey, a chemistry lecturer and inventor, and his wife, Marjorie (nee Stott), Margaret had a fascination with the stars that began with a bout of seasickness when she was four. The family was on a night crossing of the English Channel, en route to a holiday in France. She was lifted to the porthole so that she could distract herself by looking at the stars; it was the first time she had really seen those twinkling beacons and they captured her imagination.

From Francis Holland school in London, Margaret went to University College London to study astronomy, physics and mathematics. She graduated with first class honours in 1939, just as the second world war was looming, and went to work at the University of London’s Mill Hill observatory, where her observing logs indicated that she sometimes had to realign the telescope because of nearby explosions from German V1 flying bombs.

She gained a PhD in 1943 and took such joy in the wonders of the night sky that when she saw a detailed photographic plate of a spiral galaxy for the first time she said it felt almost sinful to be enjoying astronomy so much, now that it was her job and the source of her livelihood.

As the war was finishing, she applied for a postdoctoral fellowship at the Mount Wilson observatory in Los Angeles. Drawn by the sheer size of the telescopes being built in theUS, she was turned down because she was a woman, and would have had to spend nights at the observatory with married men. Writing in 1994, she recalled that the rejection opened her eyes to gender-based discrimination, “A guiding operational principle in my life was activated: If frustrated in one’s endeavour by a stone wall or any kind of blockage, one must find a way around it — another route towards one’s goal. This is advice I have given to many women facing similar situations.”

Remaining in Britain, she met her future husband, who was a theoretical physicist at UCL, in late 1947, and six months later they were married. Her enthusiasm for the universe persuaded him to turn his talents to astrophysics too. She finally made it to the US in 1951 with a position at the University of Chicago’s Yerkes observatory in Wisconsin. Although she would occasionally return to Britain over the coming decades, she made the States her home, and became a naturalised US citizen in 1977.

Margaret Burbidge receiving a Musser Copernican Planetarium, showing the movement of the planets round the sun, on behalf of UC San Diego in 1967. Photograph: Special Collections & Archives, UC San Diego

She applied again to join the staff at Mount Wilson in 1955, and was again turned down because of her sex. So her husband applied and won the post. Margaret then took over the fellowship he had been chasing at nearby Caltech, the California Institute of Technology in Pasadena. When he went observing, she went along as his assistant. In reality, however, she operated the telescope and ran the observing programme that would contribute to the B2FH paper.

In 1962 the Burbidges became professors at the UC San Diego, and a decade later Margaret returned to the UK on secondment to become director of the Royal Observatory Greenwich, at that point based at Herstmonceux Castle, East Sussex. Until then the post had carried with it the title of astronomer royal. However, she was not conferred this honour, breaking more than 300 years of tradition, something she would sometimes put down to politics and sometimes to sexism.

In the same year she took a stand against the American Astronomical Society (AAS) by refusing to accept the Annie Jump Cannon award, given for distinguished contributions to astronomy. Her reason was that it was only awarded to female astronomers, and in her letter to the committee she explained that “it is high time that discrimination in favour of, as well as against, women in professional life be removed”.

In response the AAS convened a working group to investigate the status of women in astronomy. In 1974 Burbidge returned to the US, and two years later was elected the first female president of the AAS. In the subsequent decades she worked across many areas of astrophysics, and helped to develop the Faint Object Spectrograph, one of the original instruments for the Hubble space telescope.

She retired in 1988, and subsequently became professor emeritus. In 2005 she and her husband were jointly awarded the gold medal of the Royal Astronomical Society.

Geoffrey died in 2010. Margaret is survived by their daughter, Sarah, and a grandson, Conner.

• Eleanor Margaret Burbidge, astronomer, born 12 August 1919; died 5 April 2020