GLOBULAR CLUSTERS

Mergers make more sense

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NEW space-based and ground-based observations[1,2] may have removed a substantial objection (perhaps the main objection) to the theory that elliptical galaxies formed as a result of the merger of disk-like spiral galaxies. This could at last force out the traditional view that most galaxies form as single objects which separated out from the expanding early Universe, and replace it with the belief — which has been growing for some years — that the history of a galaxy involves the violent combination of several pre-formed or forming sub-systems.

The basic idea that elliptical galaxies could be made from spirals began to gain a following with the theoretical work of Toomre[3] in the 1970s. During a collision, the effect of the rapidly varying gravitational field can cause the stars to share their dynamical energy around, violently relaxing the product galaxy to a more uniform spheroidal or ellipsoidal shape. Much of the gas in the disks would experience shocks and be persuaded to form stars. Subsequent supernovae and stellar winds would help the escape of most of the remaining gas.

This picture met a real difficulty when van den Bergh[4] perceptively remarked that if it were true, then it is surprising that elliptical galaxies have considerably more globular clusters per unit light output than do spirals. In our own Galaxy, the globular clusters are probably the oldest known objects, beautiful near-spherical clusters of a hundred thousand or even a million old stars, dating back to at least 12–15 billion years ago. In any collision, two spirals might just be able to hang on to most of their globular clusters, but the galaxy produced must have the same or fewer clusters per unit light output than the parent spirals. As ellipticals have, on average, over twice as many globulars per unit light output as do spirals, this makes it difficult to see how ellipticals can be the children of spirals.

The way out is to follow up[5] the suggestion that new globular clusters are formed in the mergers. At first acquaintance this idea seems almost heretical, given the undisputed great age of our Galaxy's globulars — it is almost like proposing that Egyptian pyramid building has continued right up to the present day. Perhaps we should not be so unprepared, as there are known to be bright young spherical clusters in the nearby Magellanic Cloud's irregular galaxies. These, known as 'populous blue clusters', show many, if not quite all, the characteristics that imply that they will look just like our Galaxy's globular clusters after another 10 billion years of ageing.

Possible young globular clusters have been seen[6] in the galaxy NGC3597, but the ground-based observations did not have sufficient spatial resolution to demonstrate that they were as physically compact as conventional globulars. Another

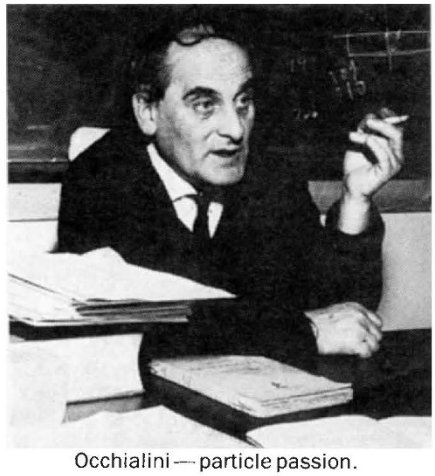
OBITUARY

G. P. S. Occhialini (1907–93)

IN a sad coincidence, G. P. S. (Beppo) Occhialini died on 30 December last year within a few weeks of Bruno Rossi and a few months of Bruno Pontecorvo, three of the greatest Italian physicists of the same cultural generation. Occhialini graduated in Florence in 1929, and under the influence of his father Augusto, also a professor of physics, at 24 he joined the Cavendish Laboratory in Cambridge, under the great P. M. S. Blackett.

He brought to the Cavendish the coincidence counter technique ("alla Rossi") and applied it to the Wilson chamber, which until then had been triggered randomly and thus only rarely captured a decent picture of a cosmic-ray track. The new circuit was an immediate success: "One on each, Beppo!" Blackett exclaimed. Next came the famous picture of the first electromagnetic shower and the confirmation of the discovery of the positron by C. Anderson, who narrowly beat them to publication.

After a few years in the increasingly difficult climate of fascist Italy, he went to Brazil to work at São Paulo and later disappeared in the Itatiaya mountains to wait out the Second World War. Just before its end, he emerged to move on to the second great British adventure of his life: Bristol, the Wills Laboratory and C. P. S. Powell. There he immediately grasped the potential of photographic emulsions for elementary particle work. After researching with the photographic company Ilford on how to increase their 'half tone' plate sensitivity, Occhialini personally exposed a group of the new plates at the Pic du Midi in the Pyrenees. This was during the course of a speleological campaign, another of his great passions. When the plates were developed, in Powell's words, "...a whole new world was revealed". After much scanning, at last they discerned an unambiguous sequence: a particle of "relatively small mass" produced a nuclear disintegration at the end of its range. This was the discovery of the π-meson decay.



Occhialini — particle passion.

Blackett and Powell separately won the Nobel Prize for their work on elementary particles. Both awards were made in difficult, Cold War years, and Occhialini had never made a secret of his political ideas. Pontecorvo summed it up nicely, in a famous toast: "I drink not to Beppo, but to us all: may we collaborate with him, it is a practically sure way of winning a Nobel Prize". After a few important years in Brussels, Occhialini came back to his father's chair in Genoa and, from 1952, in Milan. Under his leadership research groups were born which largely focused on cosmic-ray studies (the 'G-stack collaboration'), but also covered the transition of elementary particle work to accelerator physics ('K-collaboration') and the beginning of space physics. In the latter field, Occhialini created in Milan a truly European school of high-energy astrophysics, out of which came two generations of active scientists.

Above all, Beppo was instrumental, together with E. Amaldi and others, in starting the European Space Research Organization, and in giving an impetus to its scientific programme from which the present-day European Space Agency still benefits. Among the first to grasp the importance of gamma-ray astronomy, he was one of the founding fathers of the COS-B project. A large fraction of its success can be traced to his scientific and human guidance.

To work with or for Beppo Occhialini has been a privilege of many scientists in diverse fields and countries the world over. For them, days of labouring under the exacting standards he set (most of all for himself) are now cherished memories. His unique style in science and culture will continue to receive the best of compliments that we can pay to it: imitation. Giovanni Bignami

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