Mass values

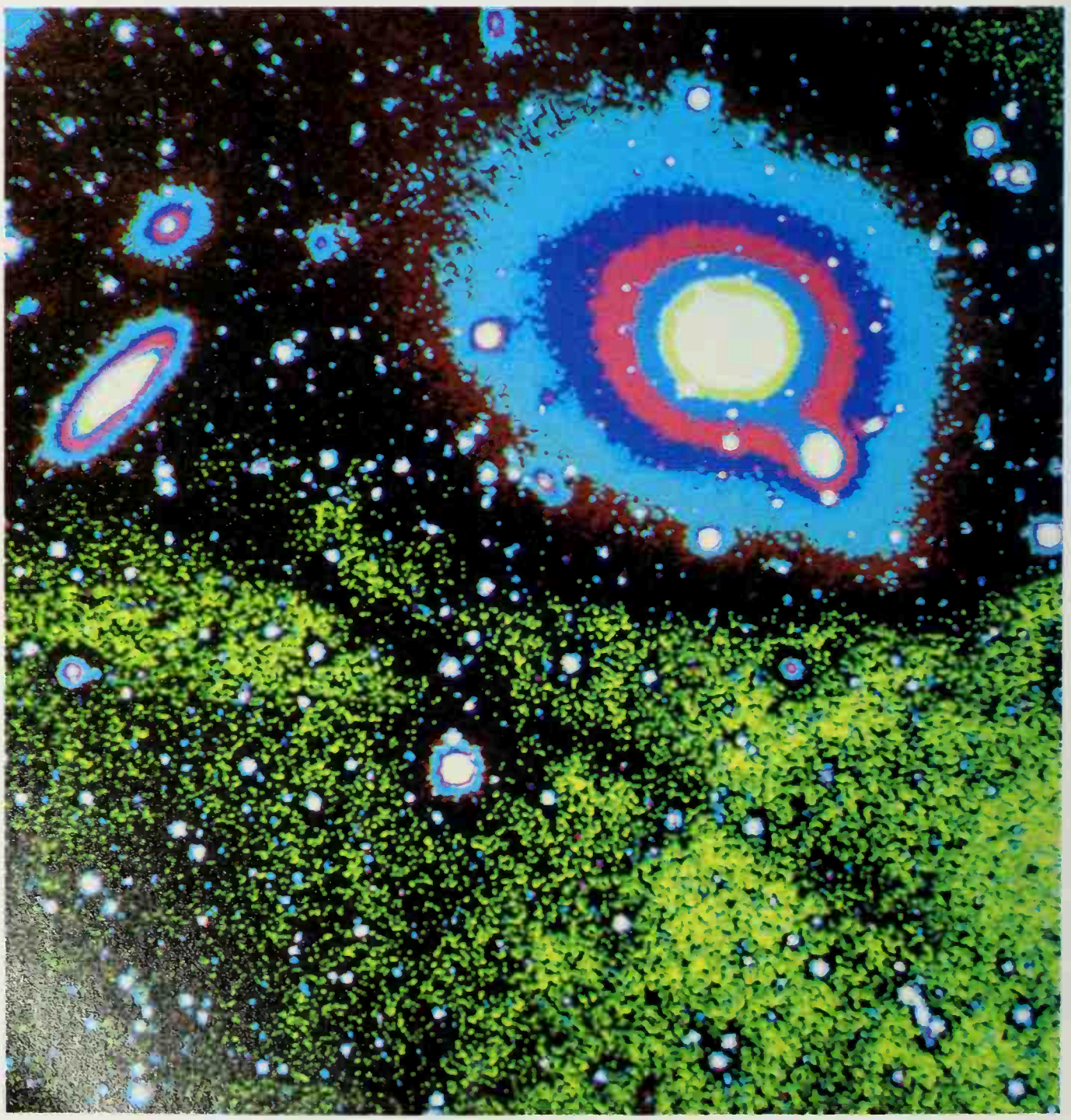
Elliptical galaxies have masses which range from about 10^5 $M_\odot$ for the smallest dwarf ellipticals up to about 10^{13} $M_\odot$ for the giant cD galaxies. Spirals have a smaller range, between about 10^9 and 10^{12} $M_\odot$. Irregular galaxies all have masses below about 10^{11} $M_\odot$.

Interacting galaxies

Systems where a large galaxy has several small companions, as with our Galaxy and M 31, are common, and, in addition, there are some other cases where two or more galaxies of more nearly equal mass are closely associated. Galaxies of different classes are found together, supporting the idea that they have essentially similar ages.

When the galaxies are close enough, optical filaments, bridges and other structures are observed optically and at the 21-cm radio wavelength. Elegant computer models based on gravitational interaction have been constructed by Alar and Juri Toomre, and lead to some particular forms observed, thus indicating that many of the strange shapes we find are indeed produced by mutual tidal distortion of the two galaxies (see diagram on facing page). It is possible, though, that some of the other distorted shapes could be due to activity in the nucleus.

One explanation of the warping commonly found in the discs of spiral galaxies is that it is a tidal distortion. For our Galaxy, the warping we observe could have been produced by the Large Magellanic Cloud, but, acording to Alar Toomre, it would need to have passed close to the Galaxy (about 20 kpc from the centre) some 5×10^8 years ago and also to have a mass rather larger than is otherwise supposed. Another problem in using a hypothesis of tidal interaction is that warping is observed in some galaxies which have no known companions. Other possibilities are that unseen intergalactic material is responsible for the warping, or that it is due to purely internal dynamical processes in the galaxy, although neither of these explanations is fully satisfactory.



Computer processing can reveal many faint features which are otherwise quite invisible. In this case a dark 'jet' of uncertain origin crosses a field of galaxies in Centaurus.