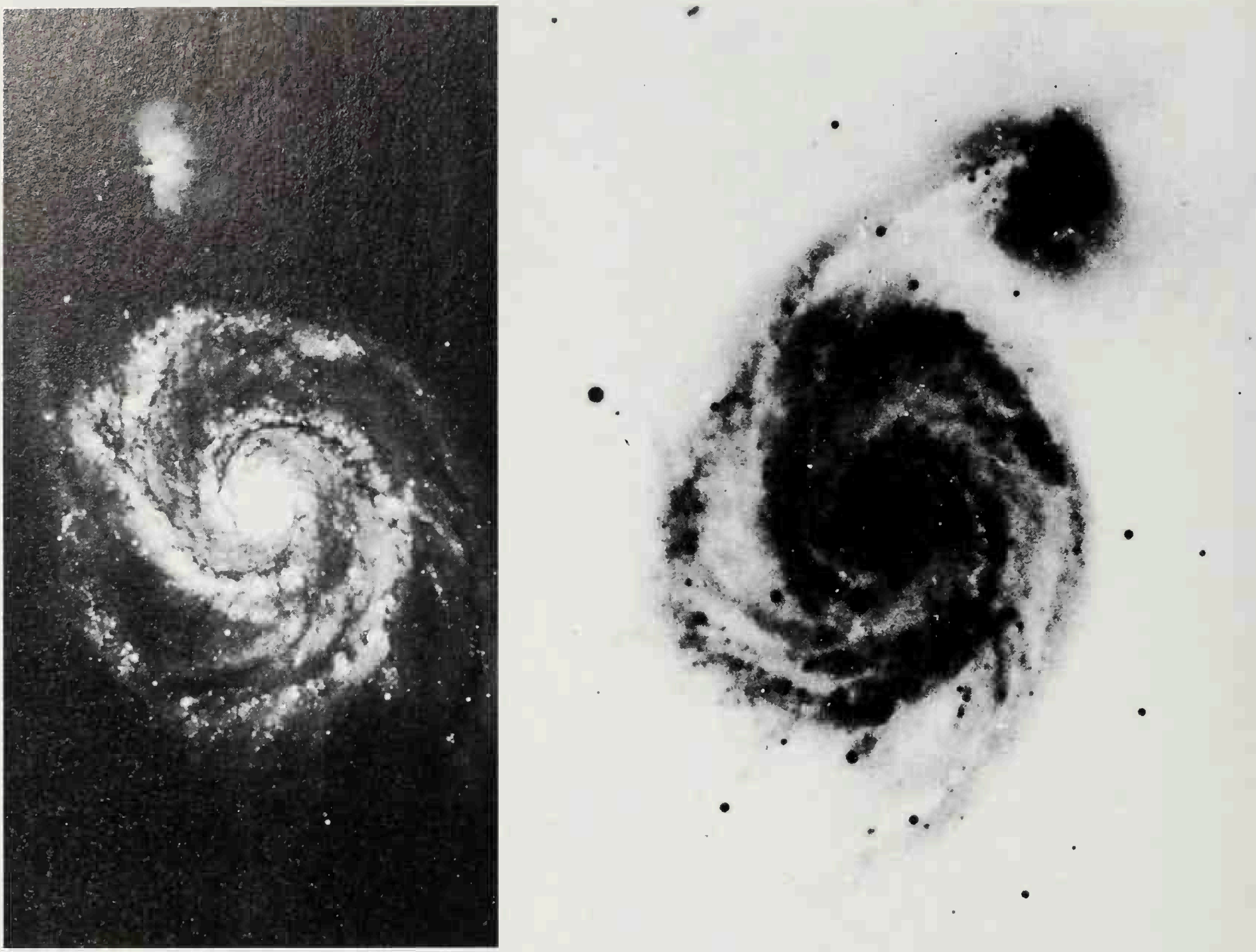

A comparison of an optical photograph (left) and an electronograph of the spiral galaxy M 51. Note how the second shows the large gaseous envelope which surrounds the satellite galaxy.

results this composite picture must be analysed, either by computer or by mapping it with a laser beam. In either case this technique of **speckle interferometry** gives results compatible with a telescope's theoretical resolving power. A picture of Betelgeuse (α Orionis) built up by computer from 2 000 speckle elements is shown on page 233 (*top*), and below it the interference pattern caused by having a double image – that of a binary star. Here the composite picture was mapped by laser, and measurement of the spacing and tilt of the fringes allowed the binary's orbit to be computed.

Speckle interferometry can improve on the results obtained at Mount Wilson in 1920, although the huge separations possible with Hanbury Brown's intensity interferometer are the only means of measuring diameters of any but larger nearby stars. Yet neither would be practicable without the use of electronic techniques: the short 0·02 s or less exposures used in speckle interferometry, for instance, would not be possible unless the telescope images were first electronically enhanced in brightness. The methods used to do this vary in detail but basically all depend on allowing the light to fall on a photo-sensitive material, that is a material which gives off electrons when light strikes it, and then multiplying the number of electrons by electronic means. In this way, a bright picture may be built up of a dim optical source.

Just as radio telescopes may be used together for interferometry, so it has been proposed that such techniques could be applied to optical telescopes. With the increasing use of electronic detectors and computer processing of images (see page 235) it is almost certain that this method could be applied to give very high resolutions of many astronomical objects.

Electronic detectors

Besides the interferometers mentioned above, there are two other devices which are achieving important results using electronic techniques – the **electronographic camera** and image photon counting system. The electronographic camera (Fig. 9·6) has a photosensitive cathode or photocathode on which the telescope image falls. This emits electrons which pass down an **electron multiplier** in which each electron triggers off the emission of others. These electrons finally hit a special photographic plate. The electrons need a vacuum in which to move but, although in the original camera of this type designed in 1952 by André Lallemand the photographic plate had to be used in a vacuum too, in the new design by James McGee and David McMullan this is not necessary. Such cameras are some five times more efficient than those of ordinary type.