

Solution 1(c)

The central region of a galaxy requires high spatial resolution (optical spectroscopy) and often HI is absent, so optical spectroscopy from emission lines of ionised gas are used. In the disc region the HI gas is more uniformly distributed and often extends beyond the visible disc, making it a better tracer of the true rotation curve. To observe such gas we need infra-red observations.

Orientation:

The centre of any line will be red-shifted with respect to the laboratory line because of the galaxy's recession. The parts of the galaxy which are approaching the observer give rise to blue shifted lines w.r.t. to the observed line centre, whilst those which are receding give rise to red-shifted lines. The Doppler shift can be converted directly into a velocity along the line of sight.

In order to see clearly from what part of a galaxy a particular line originates, we should prefer the galaxy to be as face-on to us as possible. Unfortunately, the material in a face-on galaxy has no line-of-sight component of velocity and so there is no Doppler shift! The *maximum* shift is obtained from an edge-on galaxy but there are two problems with such an orientation. First, we have to look *through* the material of an edge-on disc; many disc galaxies have dust lanes which will obviously obscure starlight so that only lines from interstellar gas can be used. In any case, the line-of-sight passes through material which is at a range of distances from the centre of the galaxy and is hence moving at a range of velocities, making interpretation difficult. We need to compromise, choosing galaxies which are sufficiently inclined to allow us to resolve where in the disc the lines are coming from whilst still giving appreciable components of velocity in the line of sight.