# Disk Galaxies & Galactic Interactions

Spiral arm formation
Stellar population properties Chemical evolution
High-speed encounters
Tidal stripping
Dynamical friction

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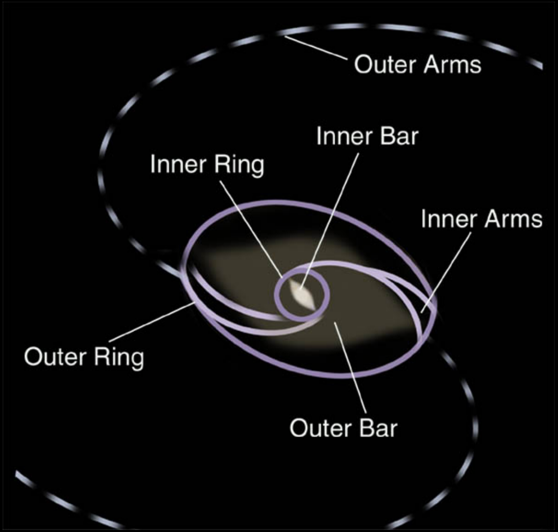
# Response of the gas



# Bending instability & Secular bulge formation

# Spiral morphology

The spiral structure must be a perturbation of the underlying disk, since it is present in all of the matter density of the disk.

For a sinusoidal variation, the surface density of a disk with $m$ spiral arms is

$$\Sigma(r, \phi) = \Sigma_0(r) + \Sigma_1(r) \cos\left(m\phi + f(r)\right)$$

Typically, the shape function describing the spiral form is

$$f(r) = f_0 \ln r + \phi_0$$

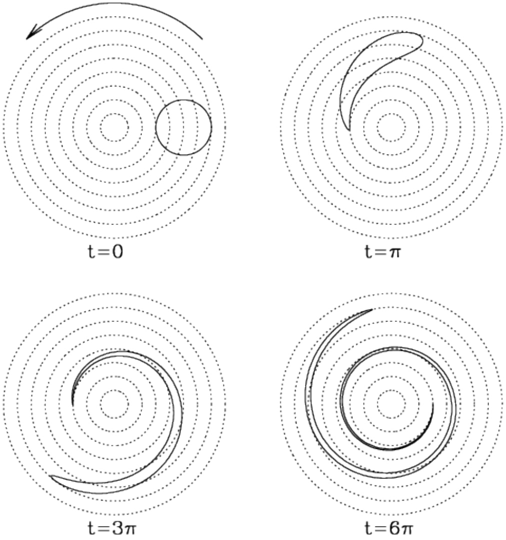
This is often expressed in terms of the pitch angle, $i$, where

$$\tan i = m \left| r \frac{\partial f}{\partial r} \right|^{-1}$$

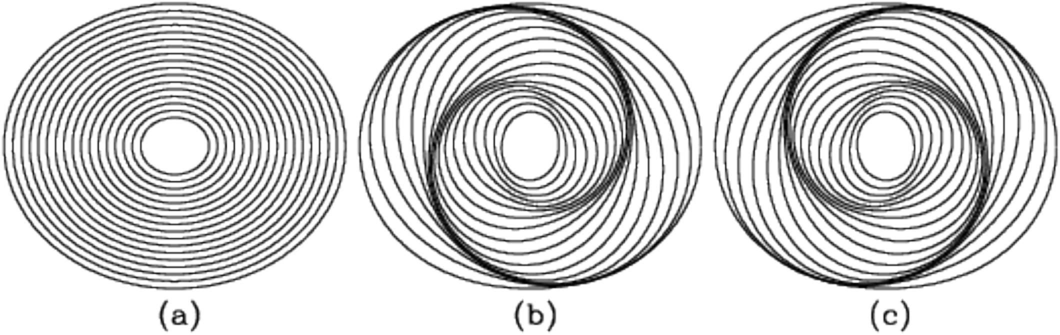
For the logarithmic spiral,

$$i = \tan^{-1}\left(\frac{m}{f_0}\right) = \text{constant}$$

# Formation of spiral arm fragments



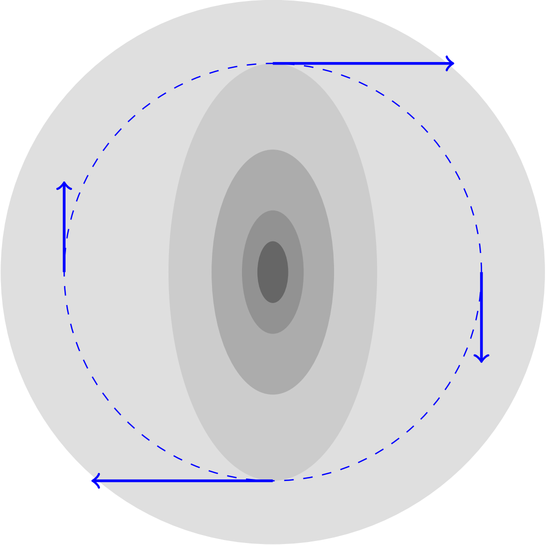

# Spiral density waves



# Bar-driven spiral arms

Gravity from the rotating non-axisymmetric part of the stellar distribution (the bar) perturbs the disk material.

- Force on orbiting objects larger than average when the ends of the bar make their closest approach; smaller than average between.
- Other things being equal, this alternately speeds up and slows down the orbital speeds.

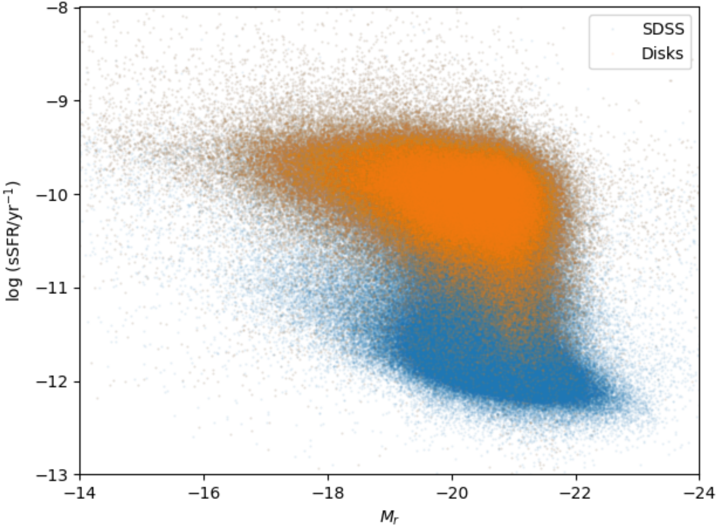


# Global trends in the stellar population of disk galaxies

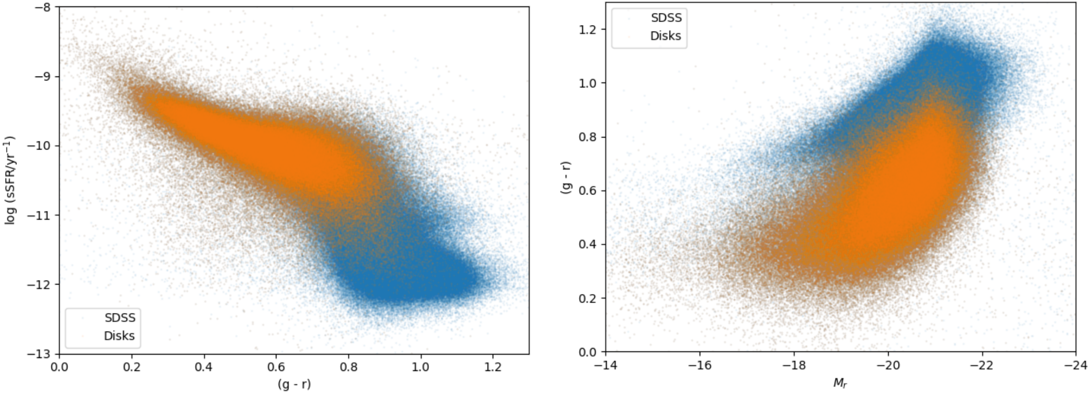
The stellar birthrate of a galaxy can be approximated as

$$b \equiv \frac{\mathrm{SFR}}{\langle \mathrm{SFR} \rangle}$$

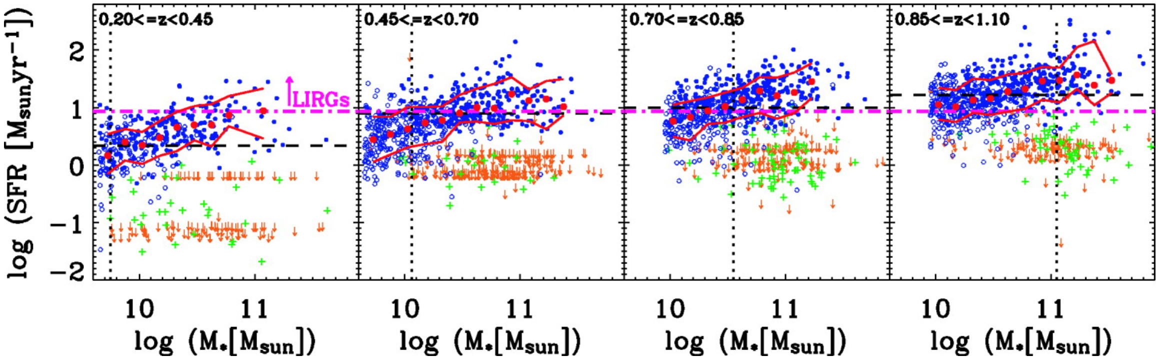
where the average star formation rate, $\langle \mathrm{SFR} \rangle = M_* / t_0$; $t_0 \simeq 10^{10}$ yr is the age of the universe.



# Global trends in the stellar population of disk galaxies



# Evolution of stellar population trends




*Noeske et al. (2007)*