Origen de las estructuras espirales

Density wave model: Lindblad proposed that the arms represent regions of enhanced density (density waves) that rotates more slowly than the galaxy's stars and gas. As gases enters a density wave, it gets squeezed and makes new stars. This idea was developed into density wave theory by Lin and Shu in 1964. They suggested that spiral arms were manifestations of spiral density waves. They assumed that stars travel in slightly elliptical orbits and that the orientations of their orbits is correlated. In other words, the ellipses vary in their orientation (one to another) in a smooth way with increasing distance from the galactic center.

It is clear that the elliptical orbits come close together in certain areas to give the effect of arms. The following hypothesis exists for star formation caused by density waves:

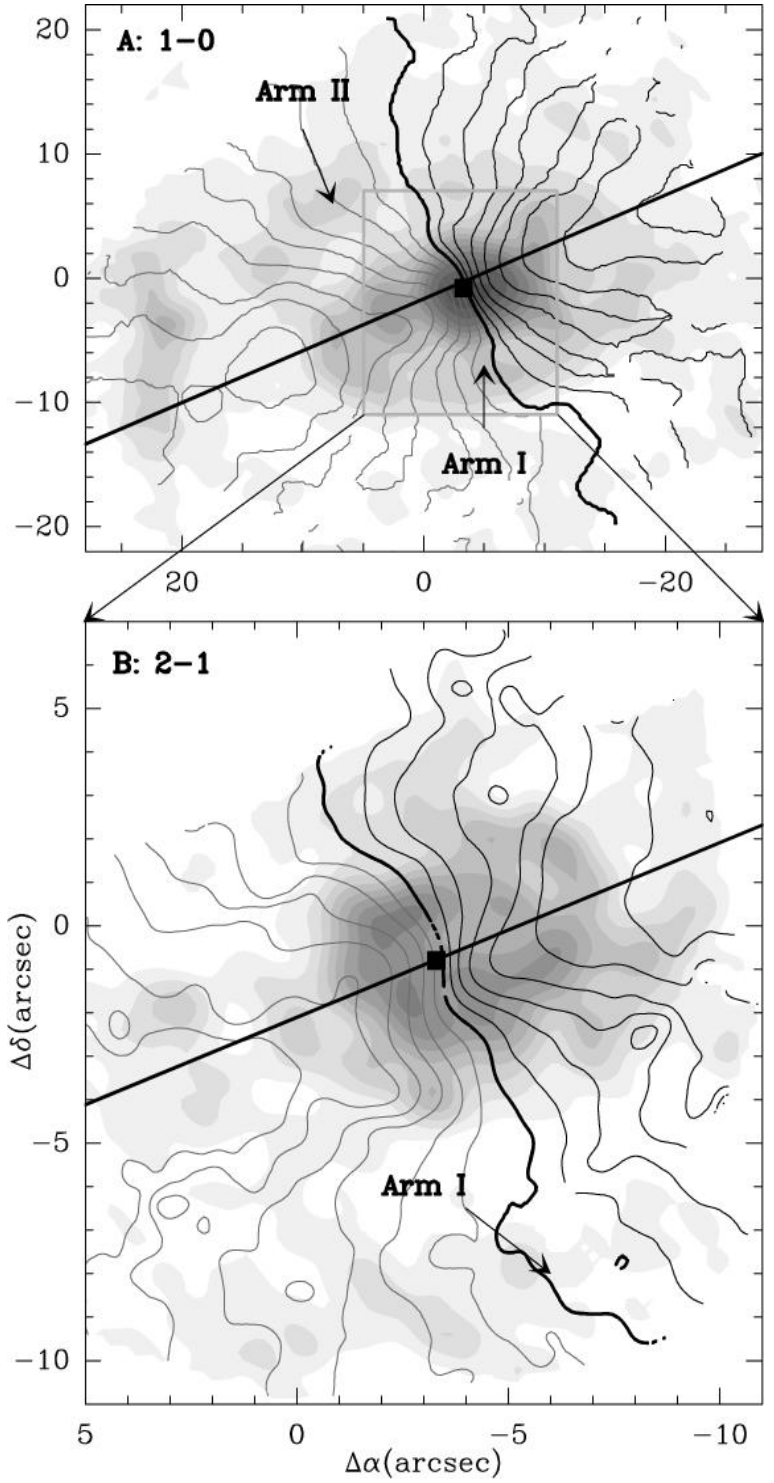
As gas cloud moves into the density wave, the local mass density increases. Since the criteria for cloud collapse (Jeans instability) depends on density, a higher density makes it more likely for clouds to collapse and form stars.

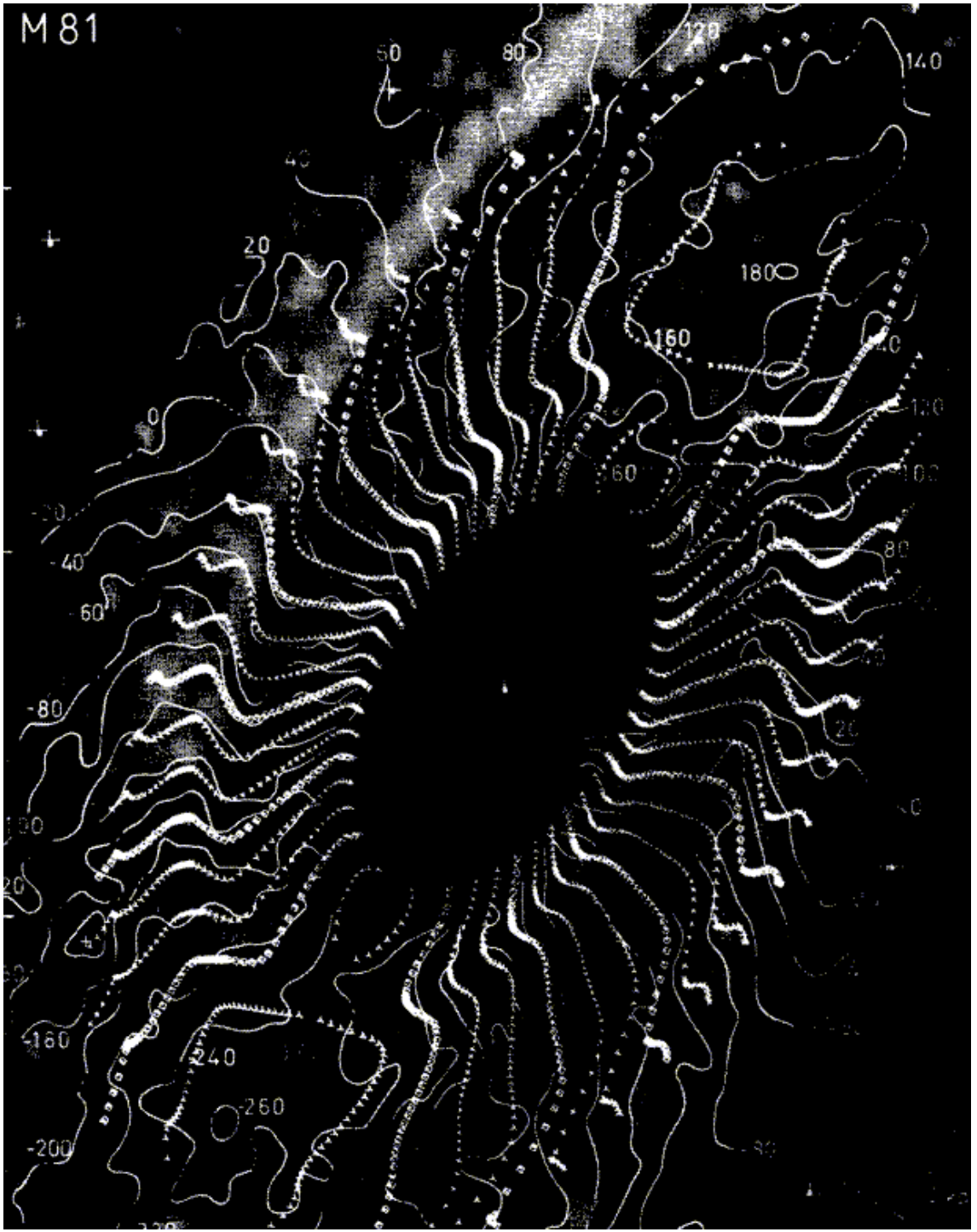
As the compression wave goes through, it triggers star formation on the leading edge of the spiral arms.

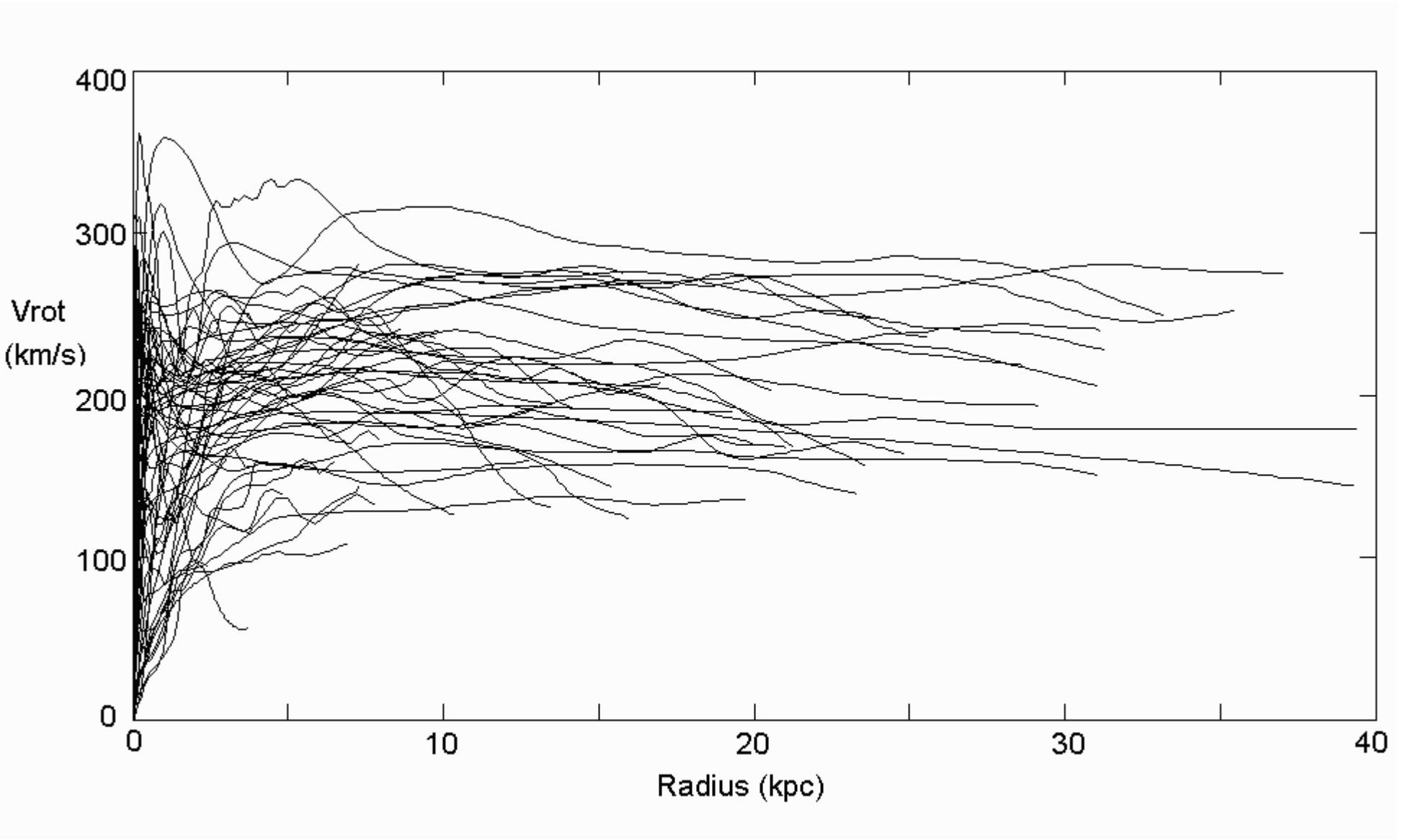
As clouds get swept up by the spiral arms, they collide with one another and drive shock waves through the gas, which in turn causes the gas to collapse and form star

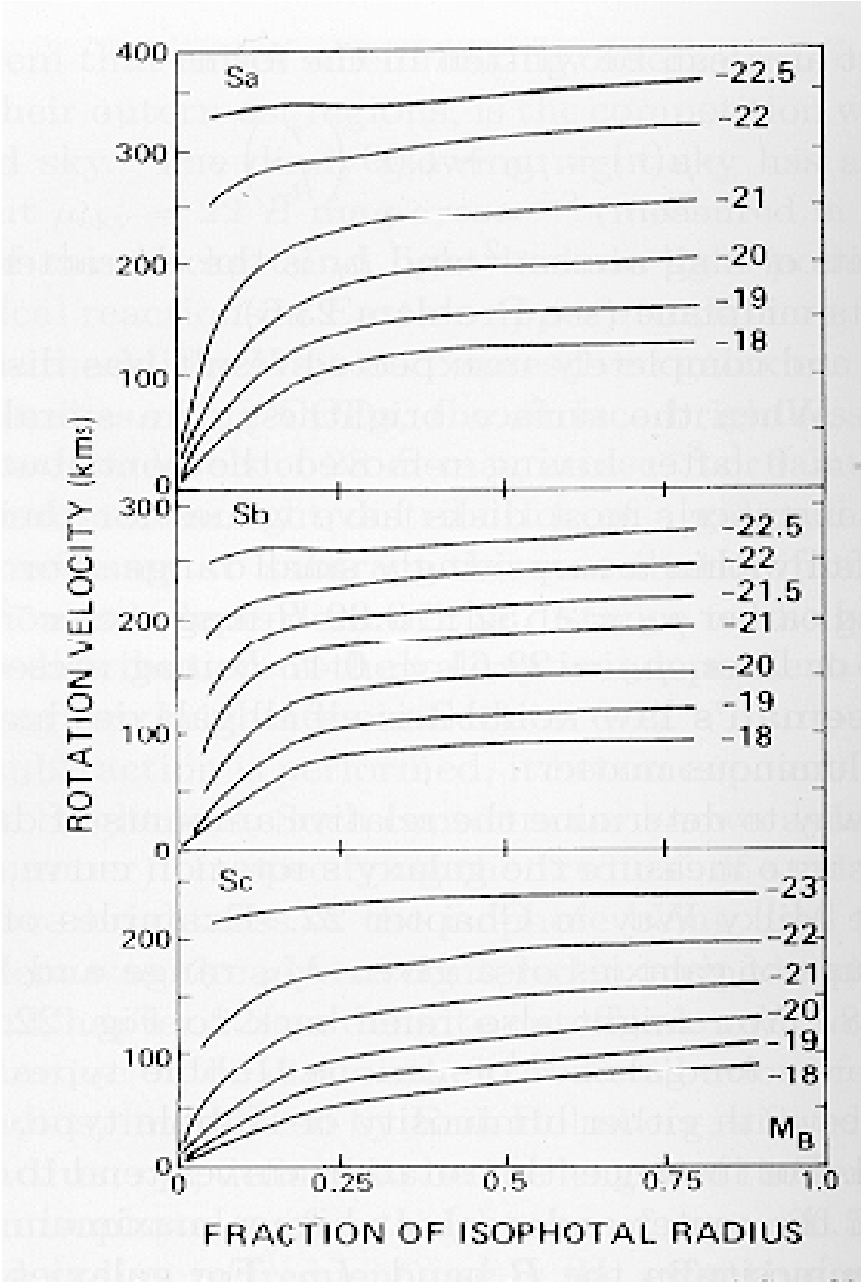
Stochastic Self-Propagative Star Formation

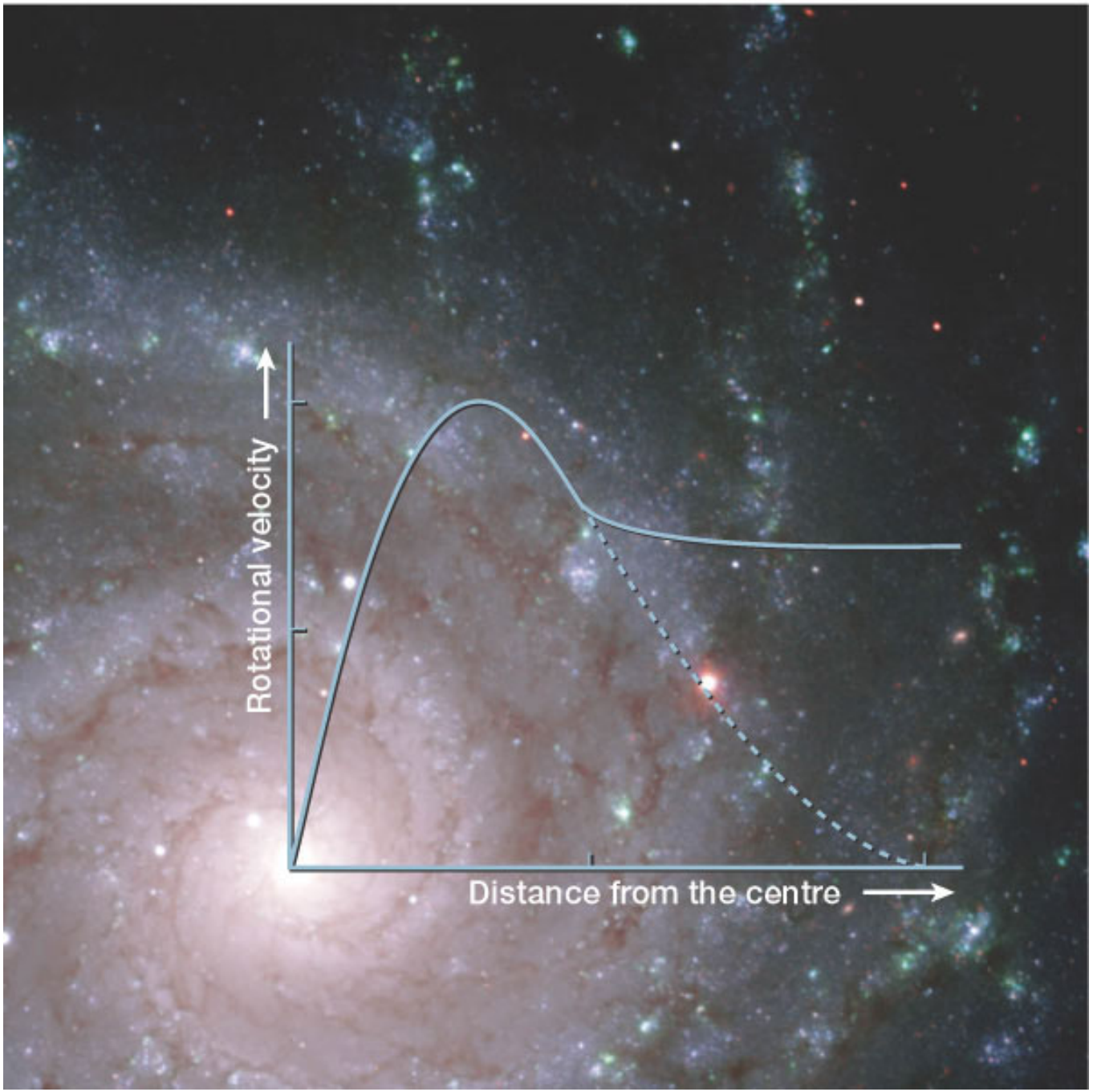
This model probably cannot explain grand design spirals, but it might be something like what causes flocculent spiral structure. Basically what it says is that if you have star formation which triggers star formation in areas adjacent to it (which is not an unrealistic idea) then as the galaxy rotates, this "self-propagative star formation" will lead to the appearance of a spiral pattern. The "stochastic" part is because there is also a small probability of random star formation in all areas in the disk which keeps things going. In a computer simulation this does infact create reasonable flocculent spirals.


A: 1−0
Arm II
Arm I
B: 2−1
Arm I
Δδ(arcsec)
Δα(arcsec)
20
10
0
−10
−20
5
0
−5
−10


M 81
50
80
120
140
20
180
160
0
-40
60
-80
-160
240
260
-200


400
300
200
100
0
Vrot
(km/s)
0
10
20
30
40
Radius (kpc)


Sa
-22.5
-22
-21
-20
-19
-18
Sb
-22.5
-22
-21.5
-21
-20
-19
-18
Sc
-23
-22
-21
-20
-19
-18
M_B
400
300
200
100
0
0
0.25
0.5
0.75
1.0
ROTATION VELOCITY (km/s)
FRACTION OF ISOPHOTAL RADIUS


Rotational velocity
Distance from the centre

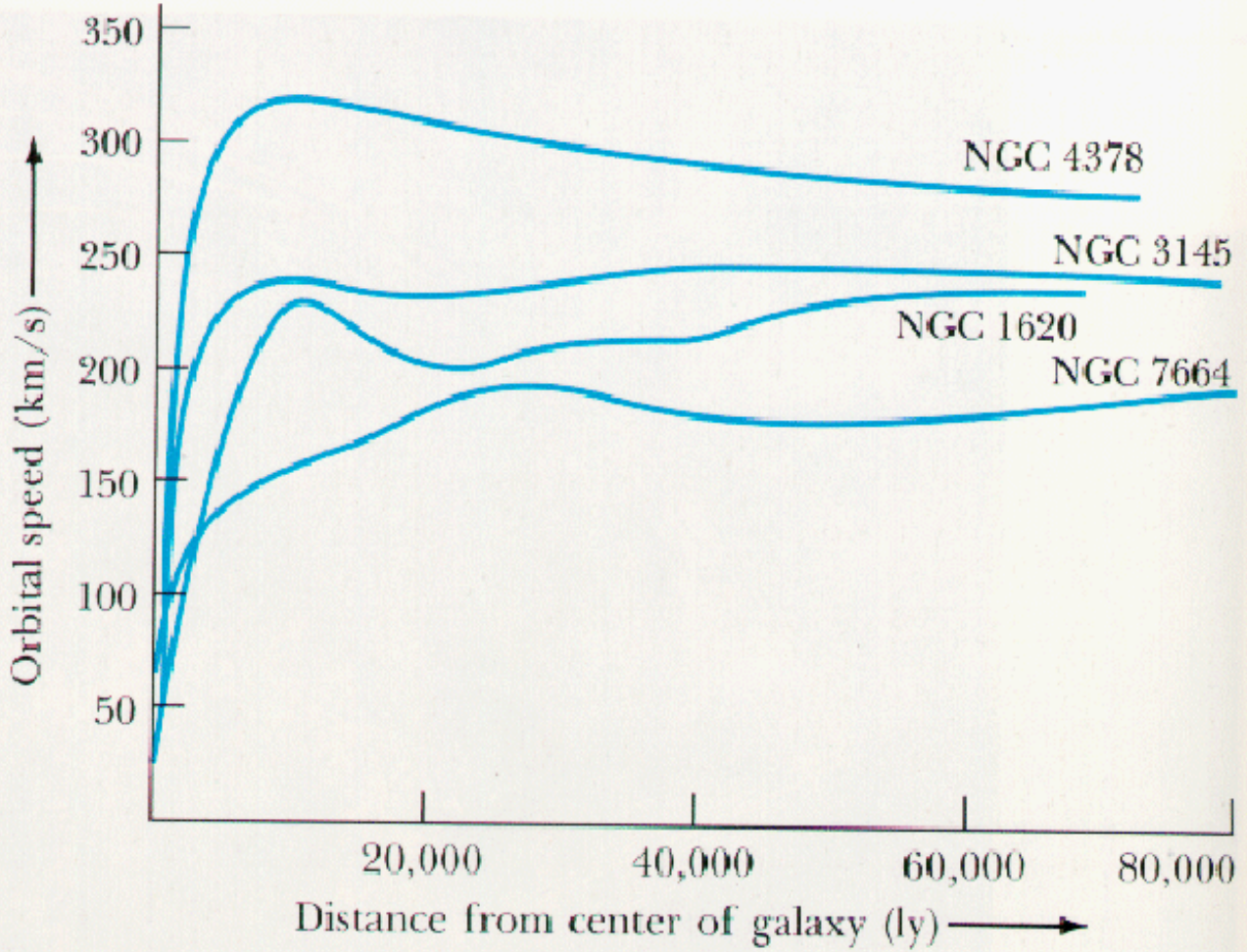
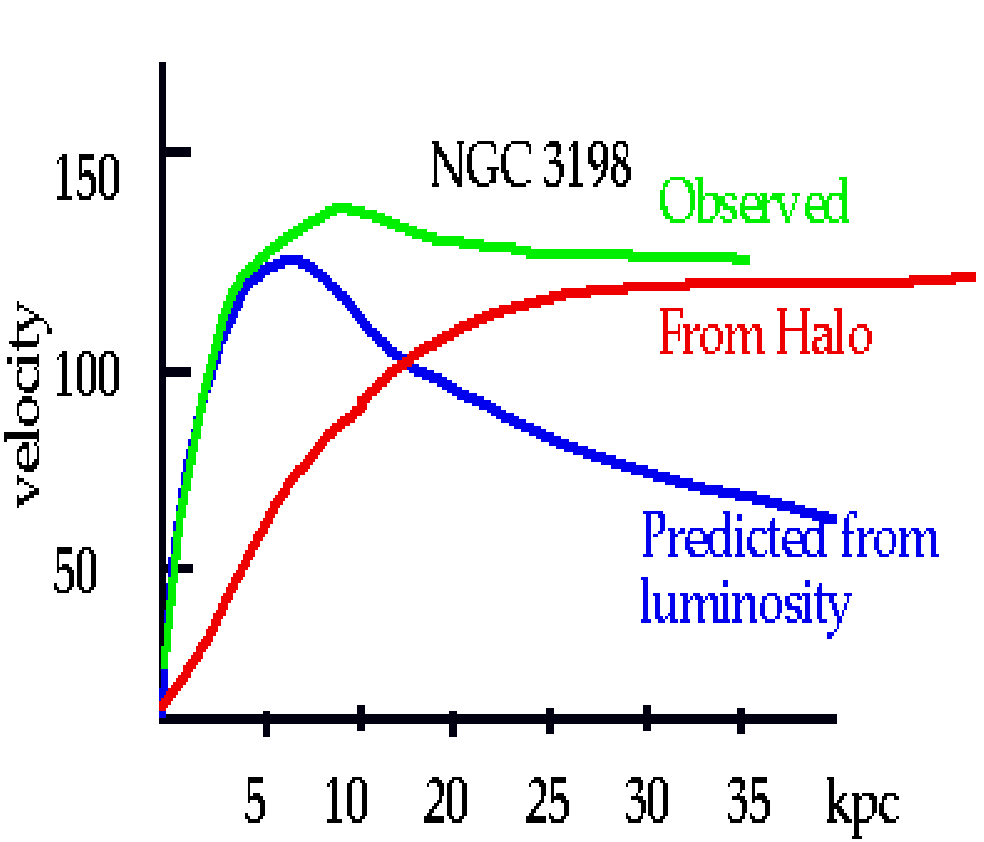
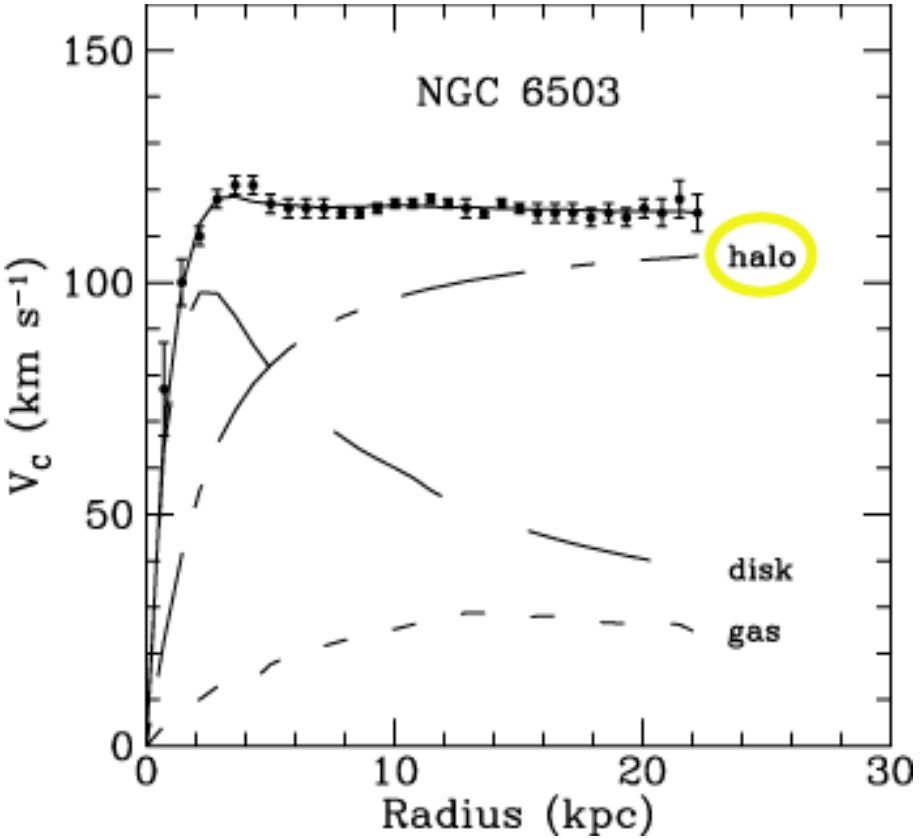


FIGURE 26-25 The Rotation Curves of Four Spiral Galaxies This graph shows the orbital speed of material in the disks of four spiral galaxies. Many galaxies have flat rotation curves, indicating the presence of extended halos of dark matter. (Adapted from V. Rubin and K. Ford)


NGC 3198
Observed
From Halo
Predicted from
luminosity
velocity
150
100
50
5
10
20
25
30
35
kpc


NGC 6503
halo
disk
gas
V_c (km s^{-1})
150
100
50
0
0
10
20
30
Radius (kpc)