DIVISION ON DYNAMICAL ASTRONOMY 265

A Dynamical Model With A "3 kpc Arm."
W. L. PETERS, U. of Texas, W. W. ROBERTS, JR.,
U. of Virginia - A dynamical model based on the
concepts of the density wave and galactic shock
wave has been considered for the bar structure
in barred spiral galaxies (1971, W. W. Roberts,
Jr., AAS Meeting, Amherst). Possible appli-
cation of this dynamical model to the inner
regions of our own Galaxy is investigated here.

The model galaxy considered is a thin disk
consisting of gaseous and stellar components
whose base state of motion is a circular motion
about the galactic center in the plane of the
disk. Superimposed on this disk is a stellar
density wave which, together with the gaseous
response, represents a bar structure in the
inner regions but which comprises only a small
gravitational perturbation on the disk of as
little as 1% from the mean. Numerical calcu-
lations on the dynamics of the gas in this model
have been carried out based on an asymptotic
analysis. The 21 cm line profiles which would
be observed in our Galaxy from neutral hydrogen
having the velocity and density distributions
predicted in the model have been determined.

The equation of transfer was applied assuming only
a uniform spin temperature and turbulent dis-
persion speed. The results show that such a gas
flow will produce a so-called "3 kpc arm" for one
orientation of the bar with respect to the sun.
The fit is promising in view of the fact that the
orientation was the only parameter adjusted to
achieve the fit, the other parameters being fixed
by prior considerations.

The Gas Content of Galaxies. WILLIAM J. QUIRK,
Hale Observatories, Carnegie Institution of Washington,
California Institute of Technology. - The follow-
ing hypothesis is suggested: "If the gas in a galaxy is Jeans
unstable, efficient star formation results." One con-
sequence of this hypothesis is that if the gas density of
a galaxy is large enough to be Jeans unstable, star for-
mation will deplete the gas until it is just barely Jeans
unstable. Provided one knows the rotation curve for a
galaxy, it should be possible to use the Goldreich and
Lynden-Bell criterion to predict the peak density of gas
as a function of radius, assuming there are no other ef-
ficient mechanisms for star formation.

An attempt is made to compare the densities cal-
culated in this way with the densities observed in exter-
nal galaxies. The hypothesis is found to predict the de-
crease in gas content and the flattening of the inner half
of most galaxies, but to overestimate the densities in
the inner half of the galaxies; this may be due to some
very inefficient star formation process which becomes im-
portant when the average gas density reaches a certain
limit.

The above hypothesis may explain the rough cor-
relation between Hubble type and gas content. It pre-
dicts that the galaxies, which according to the Lin-Shu
dispersion relation should have tight arms, should also
have a low percentage of their mass in gas.

Evidence for Density Wave Stream-
ing in Three Spiral Galaxies. D.H. ROGSTAD
and G.S. SHOSTAK, Owens Valley Radio Observa-
tory, California Institute of Technology. - Aperture
synthesis studies of the neutral hydrogen in several spiral galaxies have
yielded moderate resolution maps of their
velocity fields. In the galaxies NGC 2403,
M101 and NGC 6946 we find significant deviations
from circular rotation. These peculiar
velocities, typically on the order of 10 km/s, tend to be systematic along arcs
coincident with optical spiral arms, and
are in qualitative agreement with the
streaming motions predicted by the den-
sity wave theory of spiral structure.

Clusters of Galaxies and the n-body problem.
D.G. SAARI, Northwestern University. - Clusters
of galaxies are studied using the qualitative behavior of
J. 155, 399-407). It follows from this work that it is
not surprising that galaxies are grouped into
clusters. In one classification of clusters the be-
havior of the velocities is such that it would be
difficult to observationally determine whether
the system is bound or disintegrating. This may be a
partial answer to the question of whether "the Virial
Theorem" is measuring "hidden mass". Furthermore the
centers of mass of the galaxies tend toward well-defined
configurations. These configurations depend on the
masses and in some cases could be used to determine the
completeness of a cluster or to determine the individual
masses of the galaxies up to proportionality parameters.

Clusters satisfy a (functional) "Hubble's constant"
where the "constant" has two distinct values. Finally
there is a motion called oscillatory where in general
some of the velocities would be too large to satisfy a
Hubble's relationship. However I doubt if the veloci-
ties would be large enough to explain quasars via
dynamics (nor would it explain the absence of blue
shifts). From the dynamics one would expect this
motion to be separated from clusters of galaxies. This
seems to be true for quasars as reported by Arp (1971,
Science 174, 1189-1200).

Shock Formation Along The Perseus
Spiral Arm, And Related Dynamical Phenomena.
W. W. ROBERTS, JR., University of Virginia.
A dynamical model based on the density wave
and shock wave concepts is considered for the
Perseus arm. In this model, which represents
an extension of the two-armed spiral shock
model for the large-scale motion of the inter-
stellar gas in the outer parts of the galactic
disk, the Perseus arm is visualized to consist of
a galactic shock wave embedded in a back-
ground density wave. The large-scale system-
atic motion observed along the Perseus arm can
be accounted for as the systematic motion
predicted in the model. Splitting of an H I
feature into multiple subcomponents of the
type found in observed profiles of neutral
hydrogen arises rather naturally in the
presence of a galactic shock. The inter-
stellar absorption line components which
are seen in front of large O-associations
and which have considerably larger negative
velocities than the associations themselves
and thus according to the equilibrium Schmidt
model of rotation should refer to material
behind these associations, also find a rather
natural interpretation with a shock wave which
are observed in the outer parts of
external spiral galaxies and our own Milky Way
System.

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