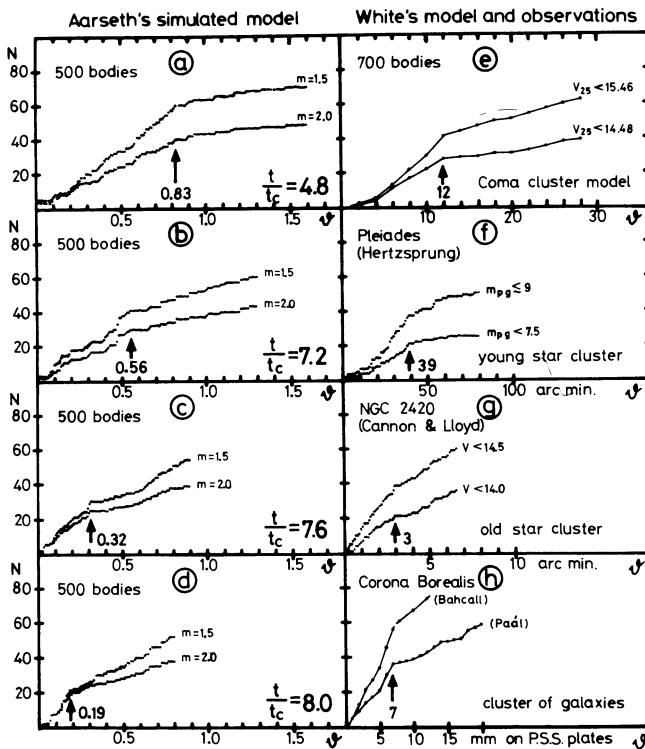# AN ANALOGY BETWEEN SIMULATED AND ACTUAL
CLUSTERS OF DIFFERENT KINDS

G. Paál

A study of clusters is presented by means of the function $N_m(\theta)$, i.e. the total number N of members heavier than a limiting mass m, as a function of the limiting projected angular distance from the centre θ. As a rule such a function is found to possess a well-defined maximum change of slope – an apparent "deflection" – if the limiting mass is large enough (see Figure 1 a-g). Some possible definitions of this deflection and the corresponding special "core radius" of the cluster are described elsewhere (*Astrofizika*, 7, 435, 1971). The typical occurrence and rather regular behaviour (systematic temporal variations) of this deflection in a sample of 17 configurations simulated by S.J. Aarseth and S.D.M. White for different conditions prove this feature to be a natural consequence of the gravitational interaction of many bodies in a statistical sense; it is apparently a characteristic of core formation and the evolution of clusters. In the case of computer data the existence of such deflections cannot possibly be due to any observational error or uncertainty or erroneous personal judgement. The corresponding diagrams, $N_m(\theta)$ for clusters of galaxies (see also loc. cit.) are found to be practically indistinguishable from those of star clusters and simulated systems. They show the very same type of deflection, the same remarkably small dependence on the choice of the limiting mass, that of the "centre", the field correction etc. As simulations give just the same diagrams as have been obtained observationally it is plausible

Figure 1.

to regard also these observational findings as dynamically necessary and
not chance coincidences, unless the actual clusters of galaxies are
stabilized by some continuously distributed intergalactic "hidden matter"
instead of the masses of observable discrete bodies themselves. However
one can hardly accept a radically different explanation for the appar-
ently identical phenomenon in the case of systems of galaxies on the one
hand and those of stars on the other. Estimates of the crossing time t_c
of the systems together with morphological arguments and numerical
experiments indicate that actual "rich" clusters of galaxies might
typically be near a particular epoch of very rapid systematic cosmologi-
cal evolution. A considerable decrease of the aforementioned "core
radii" (a transition between two nearly constant values) with the other
characteristic sizes of the systems almost unchanged (Figure 1 a-d).
The corresponding phenomena were detected earlier observationally and
consequently these empirical data, together with their consequences, now
seem to be once again corroborated (see e.g. *Astron. Nachrichten*, 297,
311, 1976). These remarkable analogies suggest that a similar mechanism
is responsible for the formation and evolution of conspicuous cores of
clusters and a similar solution of the somewhat controversial situation
with regard to mass segregation both for clusters of galaxies and open
star clusters (e.g. by properly choosing the initial conditions).

STRUCTURES AND NUMBER-DENSITY DISTRIBUTIONS
IN CLUSTERS OF GALAXIES

F. W. Baier

I would like to present some preliminary results of an investigation
of 50 clusters of galaxies. For studying the clusters, Schmidt plates
taken with the 2-metre universal telescope at Tautenburg and the prints
of the Palomar Sky Survey were used. For all the clusters we determined
isopleths to obtain detailed information about the distribution of
galaxies. We have found well isolated clusters, double clusters, multi-
ple systems and rather complicated structures.

Because we cannot say anything about physical connections between
the various groupings in the cluster regions under investigation, we
certainly have to expect a high percentage of random projections of
independent clusters. But we cannot exclude the possibility of physical
connections between the various groupings in those cases in which we
observe an irregular but well isolated structure.

For the isolated clusters we calculated projected radial number-
density distributions and radial cumulative distributions. From the
latter we found the total populations and dimensions of the clusters.
But these quantities have to be considered upper limits for those
clusters which are not well isolated because neighbouring clusters
produce secondary maxima in the radial number-density distribution and
increase both the total number of galaxies and the distance from the
centre to the apparent border of the cluster.