GLOBULAR CLUSTERS IN DIFFERENT TYPES OF SPIRAL GALAXIES

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ABSTRACT: Studies of globular clusters in spiral galaxies are still available for only a few galaxies with a limited range of galactic types. We have identified (or set upper limits on) the cluster systems in several edge-on spirals ranging from the early-type spiral NGC 7814 to the late type NGC 5907. We discuss the properties of the cluster systems and their relationship to the properties of the parent galaxies.

The data available on globular cluster systems in spiral galaxies are, in many respects, far more limited than data for ellipticals. Two reasons contribute to making spirals more difficult to study than ellipticals: the disks of spirals interfere through dust absorption and by cluttering images with disk objects, and spirals generally have fewer clusters (both in absolute numbers and relative to total light and bulge light). In addition, there is an added complication in interpreting cluster systems in spirals, caused by the several components contributing to the light and mass of spirals. We have observed several edge-on spirals of different types to try to expand the sample of spirals with useful data. We presently have images of the galaxies in Table I. Most are CCD images taken with the Canada-France-Hawaii Telescope, some are CCD images from Cerro Tololo InterAmerican Observatory, and a few are plates from CFHT. The data are in various stages of reduction, and results and notes are given in Table I.

Table I.
Spirals with New Data

Galaxy	Limits		Clusters		Notes
	Magnitude	Radii	Counted	Total	
NGC 2683	J≤24.8	1.0≤R≤4.0	100±31	320±110	Harris et al. 1985.
NGC 3717	V≤24.5				Detection marginal
NGC 5170	V≤24.5				Detection strong
NGC 5866	V≤24.5				Detection marginal
NGC 5907	V≤24.5	0.3≤R≤3.6	≤20	≤60	No detection
NGC 7814	V≤24.5	0.8≤R≤6.6	197±28	720±160	Detection strong

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In NGC 7814, the clusters show a significantly more extended radial distribution than the halo light, and also show a significantly flattened distribution, consistent with the flattening of the halo light. The flattening is perhaps surprising in view of the lack evidence for flattening for the cluster systems in other disk galaxies with flattened halos. Spherical distributions have been found in NGC 4594 and NGC 3115. There is evidence for flattening of the metal-rich subsystem of clusters in our Galaxy, but these clusters make up only a small fraction of the total Galactic system, and the shape of the Galactic halo for comparison is not well known. Previous kinematic studies indicate the flattening of the halo of NGC 7814 is a result of its rotation, not its disk mass which is not very significant. This result suggests that the cluster system is also rotating. The rotation of cluster systems in some galaxies with flattened halos like NGC 7814, and the lack of rotation in others like NGC 4594, might be explained under several different pictures for the origin of angular momentum and the relative time of cluster formation in disk galaxies.

The specific frequency S (the number of clusters normalized to total M_V of -15) for spirals is known to depend strongly on Hubble type. However, computing S using the spheroidal luminosity rather than the total luminosity gives similar values for the few spirals that have data. Table II gives the present status. The values of S(spheroid) are similar to those for elliptical galaxies lying outside rich clusters. For these cluster systems, however, the spatial distribution of the cluster systems differs (at least in some cases) from the spheroidal light, introducing the practical problem of how to compare the clusters with the light. Also, a difficulty sometimes occurs in separating the disk light, even when edge-on. In the late type spirals NGC 5170 and NGC 5907, there is no central bulge visible, and the minor axis light profile is dominated by the disk, probably to large enough radii to prevent detecting any spheroidal component. In several cases, the decomposition of an exponential disk, thick disk, bulge, and/or halo can be model-dependent. A comparison of the cluster population with galactic mass (within some radius) can be done through the galactic rotation velocity. The tendency is for late-type galaxies in Table II to have fewer clusters, in spite of their generally healthy rotation curves. The lack of clusters detectable in NGC 5907 is perhaps the clearest example of this trend. Hence a frequency relative to mass, S(mass), may depend on Hubble type in a manner similar to the frequency relative to total luminosity.

Table II.

Disk and S0 Galaxies with Cluster Data

Galaxy	Classification		V_0	W_{HI}	i	S(spheroid)	References
	RSA	RC2	(km s^{-1})		(deg)		
Galaxy	SbI-II	SXT4	...	450	...	2.2±0.5	Harris, W.E. 1981, Ap.J. **251**, 497.
M31	SbI-II	SAS3	-61	540	78	4.2±1.5	Harris, W.E. 1981, Ap.J. **251**, 497.
NGC 891	Sb	SAS3?/	706	490	90	≤0.1?	v.d. Bergh et al. 1981, A.J. **87**, 494.
NGC 2683	Sb	SAT3	373	454	82	9±3	Harris et al. 1985, A.J. **90**, 2495.
NGC 3115	S01(7)	L-/	472	...	~90?	2±1	Hanes et al. 1986, Ap.J. **304**, 599.
NGC 3717	Sb(s)	SA3:/	1477	433	83	...	This paper.
NGC 4565	Sb	SAS3?/	1122	524	90	0.9±0.5	v.d. Bergh et al. 1981, A.J. **87**, 494.
NGC 4594	Sa+/Sb-	SAS1/	963	750	84	3±1	Harris et al. 1984, A.J. **89**, 216.
NGC 5170	Sb:	SA5:/	1347	629	~88	...	This paper.
NGC 5866	S03(8)	LA+/	874	...	90	...	This paper.
NGC 5907	Sc	SAS5:/	780	491	~89	...	This paper.
NGC 7814	S(ab)	SA4:/	1249	(490)	90	...	This paper.