ROTATIONAL VELOCITIES AND CENTRAL VELOCITY DISPERSIONS FOR A SAMPLE OF SO GALAXIES

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The following discussion is based on a paper of the same title co-authored with Allan Sandage in the January 1, 1983 Astrophysical Journal.

Central velocity dispersions and rotation curves to radii of ∿5 kpc have been measured for 32 galaxies, mostly field SOs. Our rotation curves confirm the result of Kormendy and Illingworth (1982) that the bulges of SO galaxies are in rapid rotation, with enough rotational kinetic energy to account for their flattenings. The V/σ-ellipticity relation we find for SO bulges is compared with similar data for

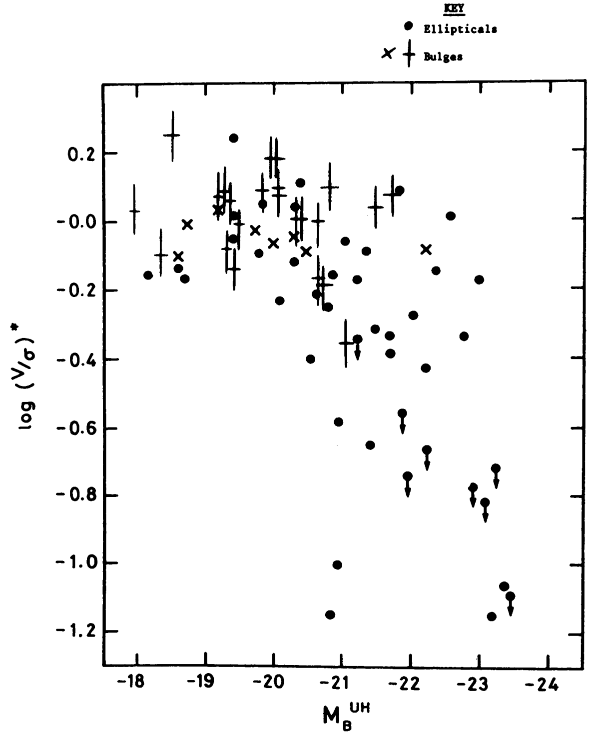

Fig. 1. Davis et al. Fig. 5 showing ratio of rotational-to-pressure support for ellipticals and bulges. A value of $(V/\sigma)^* \approx 1$ indicates an isotropic oblate rotator. Bulges from our sample are shown as crosses. All bulges, even luminous ones, are consistent with oblate models.

E. Athanassoula (ed.), Internal Kinematics and Dynamics of Galaxies, 271–274.

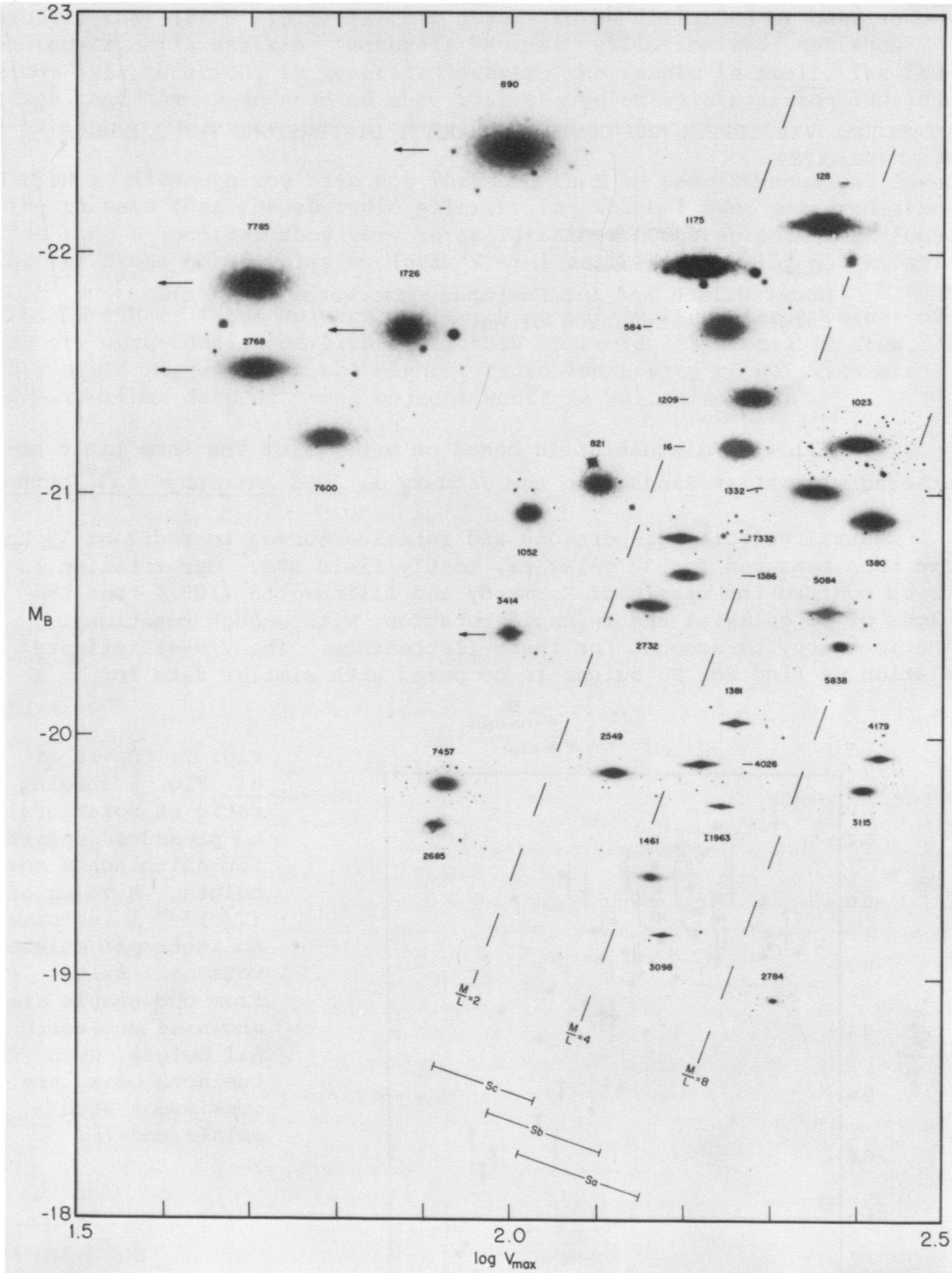

Fig. 2. The Tully-Fisher diagram log V_{max} vs. absolute blue magnitude for field SOs. The position of each galaxy is marked by a photo which indicates its relative size. Representative lines of M/L = constant are shown as well as the region of the diagram occupied by spirals of different Hubble type.

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elliptical galaxies from Davies et al. We conclude that (1) faint S0 bulges and elliptical galaxies (M_B fainter than -20.5) are both consistent with oblate rotators with isotropic velocity dispersions (although the S0 bulges in our sample are flatter than ellipticals, on the average) and (2) bright S0 bulges, $-22.0 < M_B < -20.5$ are also consistent with oblate models but bright ellipticals are not. This is demonstrated in a plot of M_B vs. $(V/\sigma)^* \equiv (V/\sigma)_{obs}/(V/\sigma)_{oblate\ model}$ (Fig. 1) from Davies et al. (1982) to which we have added our data for S0 bulges (the crosses). It is clear that all bulges even the luminous ones, have $(V/\sigma)^* \sim 1$ and are thus consistent with oblate, isotropic models. Hence a significant kinematic difference persists between S0 bulges and ellipticals. This difference suggests that disk galaxies and ellipticals did not share a common history of spheroidal formation.

After correcting the measured rotational velocity for the inclination of the S0 disks to the line of sight and for the integration through them we produce the Tully-Fisher velocity-absolute magnitude diagram for our sample. In the Tully-Fisher diagram, Fig. 2, the positions of the galaxies in the diagram are represented by photographs from the POSS that have been enlarged in proportion to the galaxy's redshift (i.e., all are brought to the same distance). Prepared in this way, the diagram shows that galaxy radius has a small spread at a given absolute magnitude, and that surface brightness is relatively constant over this range in luminosity. It is also apparent that bulge luminosity covers a wider range than disk luminosity, therefore bright S0s are bulge dominated while faint S0s are usually disk dominated.

In this diagram, the S0s scatter over the entire region inhabited by spirals of all types. The absence of a tight Tully-Fisher relationship could be due to a combination of (1) M/L variations, (2) contamination of disk light by bulge light, (3) variations from galaxy to galaxy in the run of velocity with radius, i.e., in the dynamical structure, and (4) inclusion of galaxies without true disks in which the internal kinetic energy is then due more to velocity dispersion than to rotation. The large scatter in the Tully-Fisher diagram indicates that, in terms of disk kinematics, field S0s are a heterogeneous class, and are therefore less promising than spirals for mapping perturbations in the local Hubble flow. The S0 class seems to include transition objects from ellipticals to true disk systems without arms. These "diskless S0s" have luminosity profiles that mimic the presence of a disk, but their kinematics are indicative of a rotationally flattened bulge without a component flat enough to be considered a disk.

Finally, we compare the bulge luminosities of S0s with those of elliptical and spiral galaxies, by using the central velocity dispersion as an indicator of the luminosity (and mass) of the spheroidal component. The central velocity dispersions of a representative sample of different Hubble types are presented in histogram form in Fig. 3. The histograms show that the average central velocity dispersions of S0 bulges are intermediate between those of E galaxies and spirals of all Hubble types, indicating that S0 bulges are more massive, on the average, than the bulges of spiral galaxies. This is further evidence that the S0 phenomenon is intrinsic to the Hubble sequence rather than a result of simple stripping of the materials required for star formation from present-day spirals.

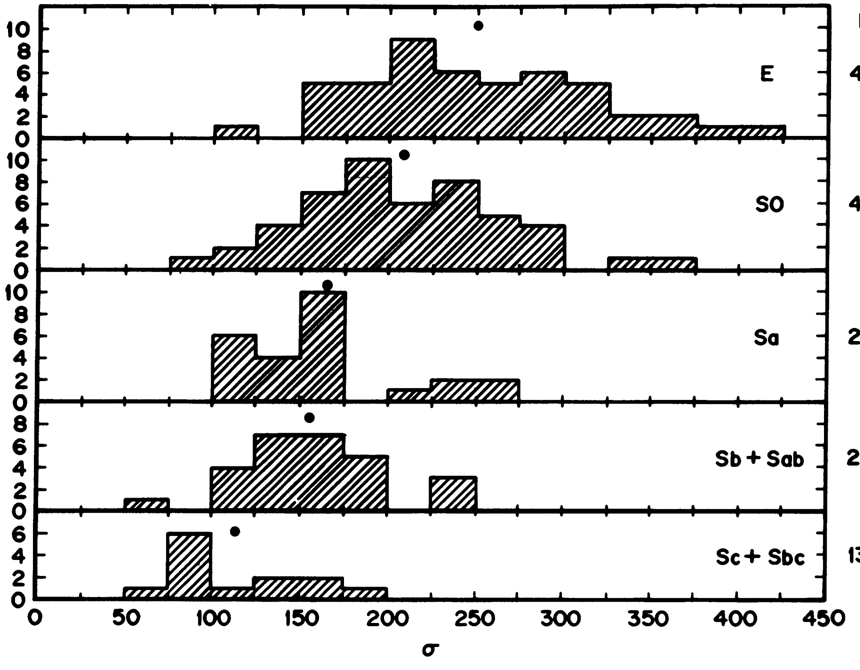

Fig. 3. Histograms showing the central velocity dispersions for a representative sample of different Hubble types.

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