Kinematics of Elliptical Galaxies in Arp Groups

There are two extreme theories for the formation of elliptical galaxies. Toomre (1977, in The Evolution of Galaxies and Stellar Populations, ed. B. Tinsley & R. Larson (New Haven: Yale Univ. Observatory), 401) has suggested that all elliptical galaxies and spheroids of disk galaxies are the product of mergers and are made up of stars that previously formed in disks. The other extreme theory predicts that the stars in elliptical galaxies were formed during gravitational collapse of a gas cloud. In order to understand the relative importance of interactions and mergers of galaxies in the evolution of galaxies we must know how often interactions occur and how galaxies are affected.

The most likely place to discover old merged disks is in a group where mergers are currently occurring. Past galaxy mergers can be studied by examining galaxies that show unusual features, such as greatly disturbed structure, high star formation rates and nuclear activity. For this study the selected galaxies have a high probability of a recent merger but are otherwise morphologically normal. The sample of galaxies consists of E and S0 galaxies in Arp groups that have minor envelope distortions but show no visible signs of dust, ionized gas or young stars. The presence of these galaxies in groups or other dense regions makes it highly probable that they were recently in the same environment of frequent collisions, and hence are exceptionally likely to have been created in a merger if that is the formation process. The existence of a kinematically distinct core subpopulation, young stars or nuclear activity would be a signature of a recent merger. Analysis and compari-

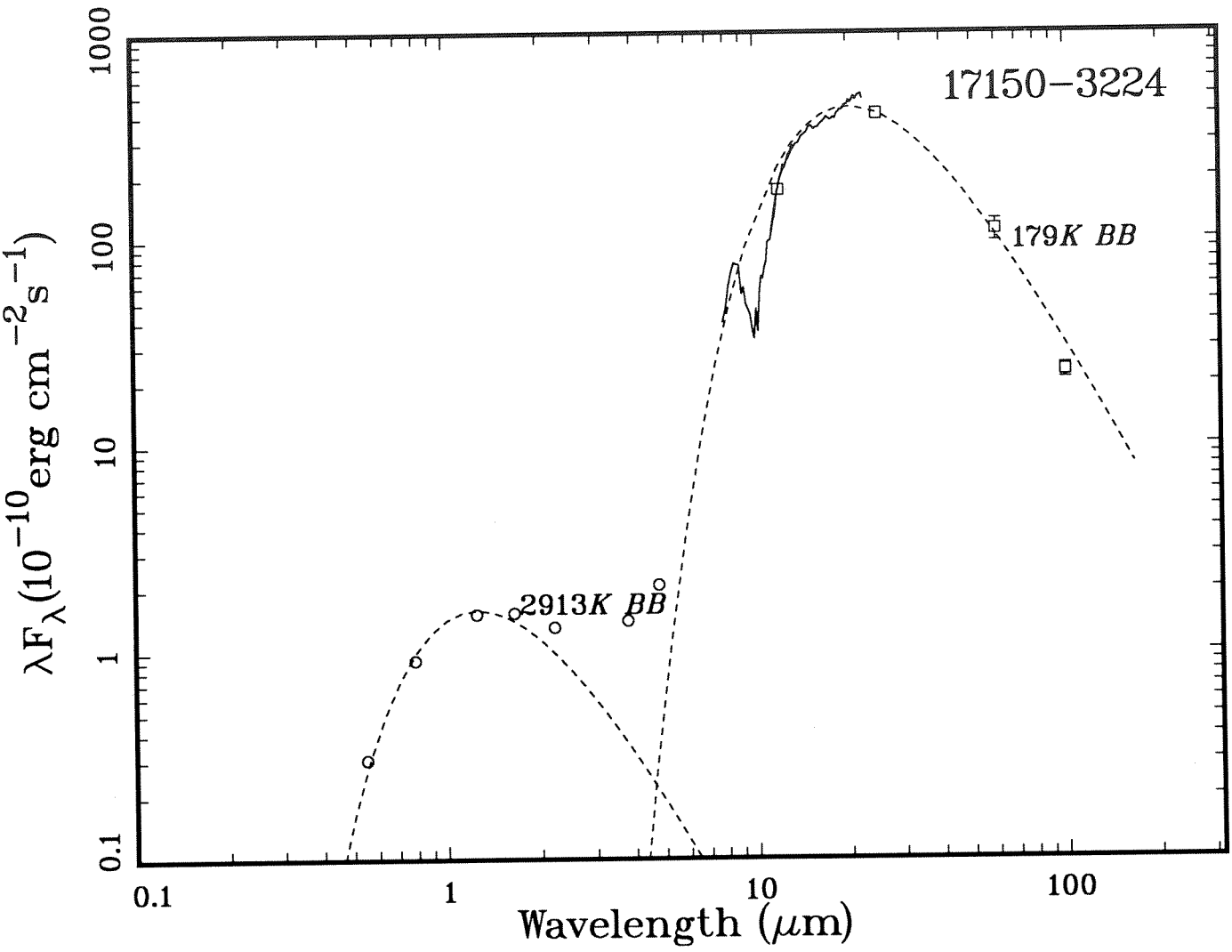

Figure 11: Plot of log (σ) versus M_B. Kormendy and Illingworths data are represented by x's. Our data is represented by filled circles with the Arp number next to each data point. These Arp galaxies do not appear to be peculiar.

son of spectra in the core region and main body of early-type galaxies allows study of core dynamics and stellar populations.

Long-slit spectra were obtained at CFHT with the Herzberg spectrograph of 10 galaxies. Two slit widths were used, 2 arcsec and 0.75 arcsec. The rotation curves and the velocity dispersion profiles for each galaxy were found using the fourier quotient method. No unusual rotation curves were found (counter and co-rotating cores or steep inner rotation curves in those cases where the outer part of the galaxy is too faint) out of the 5 galaxies in which the data is of reasonable quality. The velocity dispersion profiles also did not show any peculiarities.

Our data is compared with that used by Kormendy and Illingworth (1983, ApJ, **265**, 632) to obtain their L–σ relation (Figure 11). Our data are represented by a filled circles with the Arp number next to the data point and Kormendy and Illingworth's data are represent by x's. NGC 1889 (Arp 123) has an unusually low velocity dispersion for the assumed B-band absolute magnitude, but it should be noted that this is one of the galaxies whose magnitude is uncertain. All of the other galaxies do not appear to be unusual.

We found no evidence for unusual rotation curves or velocity dispersion profiles in our sample of elliptical galaxies. The galaxies that we observed do not show any dynamical evidence of a merger. Zepf et al. (1991, ApJ, **383**, 524) find that the colors of elliptical galaxies in compact groups are consistent with those in the field with only a few exceptions. One would expect that the merger rate in compact groups would be much higher than for field galaxies and therefore result in anomalous colors. Ellis (1992, preprint) argues that the small dispersion in the color-velocity dispersion relation indicates that elliptical galaxies are old. Rose (1985, AJ, **90**, 1927) and Bower et al. (1990, Astr. J., **99**, 530) also find that ellipticals in clusters are older than field ellipticals (6-7 Gyr older). Our observations are extremely sensitive to changes in the core whereas the above authors tend to measure the global properties of the galaxies. These results suggest that mergers that make elliptical galaxies in clusters and groups could have taken place around a redshift of 2 or 3 and are uncommon now.

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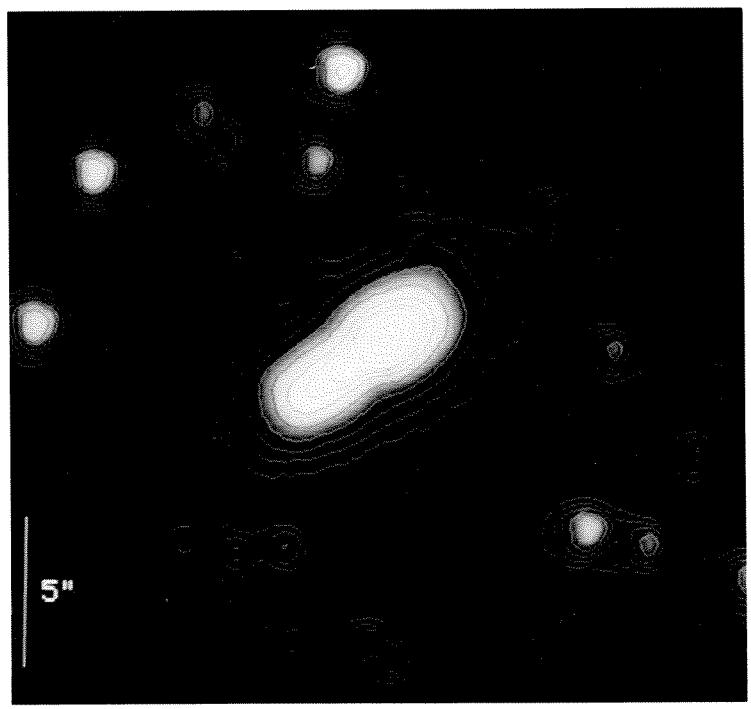
Optical Imaging of Proto-Planetary Nebulae

Through observations in the infrared and radio, particularly OH and CO lines, it has been determined that most asymptotic giant branch (AGB) stars possess slowly expanding, spherically symmetric circumstellar envelopes (J. Herman and H.J. Habing in The Late Stages of Stellar Evolution, S. Kwok and S. Pottasch eds. 55-71, 1987). However, through observations in the optical and radio, it is found that only a small fraction of the planetary nebulae, into which these AGB stars evolve, possess a spherical morphology. This raises the questions of when the transition in morphology takes place, and what is its mechanism? A clue is found from observations in the UV which show that many hot PN central stars possess a tenuous high velocity wind (~2000 km/s). It has been suggested



Figures 12a and 12 b