CORE AND TIDAL RADII OF THE CARINA DWARF SPHEROIDAL GALAXY FROM UK SCHMIDT TELESCOPE PLATES

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ABSTRACT. Core and tidal radii of the Carina dwarf galaxy are determined by fitting King dynamical models to number count radial profiles, derived from COSMOS data. These values are compared with those of the other six known Local Group dwarf spheroidals.

PREPARATION AND REDUCTION OF DATA

Six good quality UK Schmidt Telescope plates (five IIIaJ, and one IIIaF), were mapped by COSMOS and then thresholded at 10% above the local sky background level in intensity space. This level was chosen as being a good compromise between (a) enabling faint images to be detected down to the horizontal branch with a relatively high S/N and (b) reducing the effects of crowding and hence making the blending of images less severe.

All the data were paired and calibrated enabling reliable J magnitudes to be determined and a (J-R, R) colour magnitude diagram drawn so that only the giant and horizontal branch stars could be used for the following analysis, thus eliminating to some extent the very high field star contamination ($l = 260^{\circ}.1$, $b = -22^{\circ}.2$). After being binned in 2′ bins, this data was contoured and finally smoothed using a 5 x 5 gaussian filter in order that the centre of the dwarf galaxy (XC, YC) could then be defined as the (x, y) coordinate of the bin with the maximum count. The (x, y) positions of the bins with a specified count starting at a value slightly higher than that of the background, could then be fitted (after transforming them to polar coordinates with origin at (XC, YC)), using a non-linear least squares procedure, to the generalised functional form of an ellipse, with the orientation and semi-major/minor axes left as the free fitting parameters. No significant variation of ellipticity with radius was found, but the effect of the bright central star SAO 234657 in the COSMOS data makes this result hard to confirm inconclusively with the present plate material. Work is now in progress (Godwin 1984), using the larger plate scale capacity of AAT prime focus plates to try and resolve this.

Hence a mean ellipticity (0.31) and orientation (72°) could then be found for all the fitted ellipses and the original data binned

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in ellipses with these parameters. The background count was found by finding the value at which the counts summed over the ellipses levelled out. This was then subtracted from the original counts and the resulting mean radial profile with associated errors fitted to the empirical and theoretical models of King (1962, 1965, 1966). Values of $r_t = 47'$, $r_c = 9.6'$ were found. Taking the distance to the Carina dwarf galaxy as 91 kpc (Mould and Aaronson 1983), r_t comes out to be 1.24 kpc.

The effects of anisotropy in the outer regions of the Carina dwarf galaxy are now being investigated by fitting Michie models (Hodge and Michie 1969) to this radial profile (Godwin 1984).

DISCUSSION

The predicted limiting radius at perigalacticon of a stellar system moving in an elliptical orbit around the Galactic centre (King 1962) is

$$r_{lim} = R_p \left[\frac{M_d}{3.5M_g} \right]^{1/3} \qquad (1)$$

assuming elongated orbits ($e \sim 0.5$). R_p is taken to be the present distance when calculating this quantity, and hence the value derived is an upper bound for the actual r_{lim}. If the observed tidal radius is larger than this upper bound, then the Galaxy must be seriously disrupting the system. Such is the case with Ursa-Minor and to a lesser degree with Draco and from the data here (see table I) Carina.

Hodge and Michie (1969) found that the ratio of the Galaxy's tidal, to the dwarf galaxy's internal gravitational force could be expressed in the approximate form

$$\left| \frac{T_z}{V_z} \right| \sim \frac{2\,(b/a)\, M_g\, r_t^3}{D^3 M_d} \qquad (2)$$

where D is the distance to the stellar system. Using $M_g = 3 \times 10^{11} M_\odot$, these values are recomputed from the data in table I, and plotted against the mean ellipticity of the isopleths (figure 1a). As Hodge and Michie (1969) noted, and as would be expected, the closer the dwarf galaxy to the Galactic centre, the greater the role that the Galactic tidal force plays in determining the structure of its outer regions. Figure 1b shows $|T_z/V_z|$ plotted against r_t/r_c. A large value of this former ratio, should be indicative of a large Galactic influence on the dwarf galaxy, producing a low stellar density envelope at large distances from its centre. As can be seen from these two figures, the Carina dwarf galaxy joins Draco and Ursa-Minor as satellites of our Galaxy seriously affected by the Galactic tidal field.

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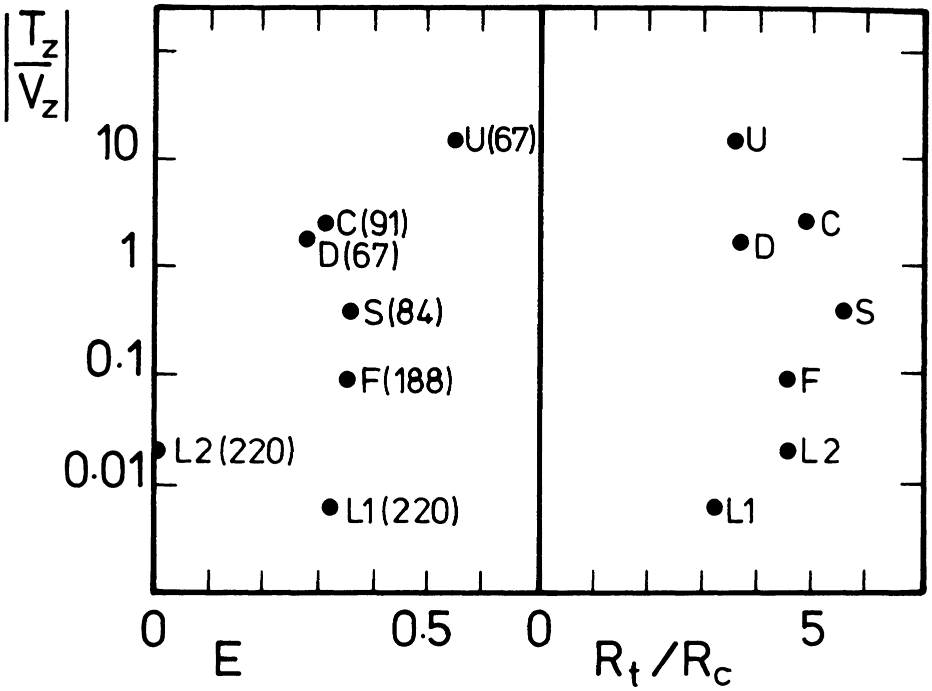

Fig. 1a,b. $|T_z/V_z|$ - ellipticity/concentration parameter relations for the Local Group dwarf spheroidals (distances in brackets).

Table I. Local Group dwarf spheroidal data.

Name	r'_t	r_t(kpc)	r_{lim}	r'_c	r_t/r_c	E	$M/M_\odot$	D(kpc)	T_z/V_z
Draco	35	0.51	0.33	9.27	3.85	0.29	1.2E+5	67	1.57
Leo I	13	0.91	3.44	4.33	3.13	0.31	4.0E+6	220	0.007
Leo II	10	0.65	2.16	2.28	4.43	0.01	1.0E+6	220	0.02
Sculptor	57	1.20	1.19	10.31	5.53	0.35	3.0E+6	84	0.38
Ursa-Minor	47	1.20	0.31	13.29	3.57	0.55	1.0E+5	67	15.51
Fornax	57	3.10	5.02	12.71	4.49	0.35	2.0E+7	188	0.09
Carina	47	1.24	0.71	9.60	4.90	0.31	5.0E+5	91	2.09

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