# Second Reference Catalogue of Bright Galaxies

# (de Vaucouleurs *et al.* 1976)

## Documentation for the Computer-Readable Version

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# 1 Introduction

**A copy of this document should be distributed with every copy of the computer-readable catalog.**

## 1.1 Description

[From the Introduction to the published catalog:]

This revised and much enlarged version of the *Reference Catalogue of Bright Galaxies* (or "Bright Galaxy Catalogue": BGC) was made necessary by the rapid growth of extragalactic astronomy since 1964. During the interval several important general catalogues of galaxies to fainter limits ($m \leq 15$) have been published. All are based in the Palomar Sky Survey plates (CGCG: Zwicky *et al.* 1960-1968) or paper prints (MCG: Vorontsov-Velyaminov *et al.* 1962-1968, 1974; UGC: Nilson 1973, 1974) as is a revised version of the NGC for objects of all types (RNGC: Sulentic and Tifft 1973). Corresponding catalogues of the southern hemisphere from the ESO and UK Schmidt surveys should follow in the next few years. Until the the exploration unbalance between the two hemispheres remains severe, especially at declination $\delta < -30°$, and statistical users of this catalogue should be aware of this fact. They should also note that the present catalogue is not intended to be complete to any specified limiting magnitude, diameter, or redshift. It is merely a compilation of data reduced to uniform systems for those galaxies which have been the object of some individual study (beyond mere inclusion in a catalog) and which are neither much smaller then $0\farcm5$ in diameter, or fainter than 16th magnitude or have redshifts in excess in 15,000 km $s^{-1}$. A special effort was made to include all the so-called peculiar galaxies which for one reason or another have attracted attention in recent years, in particular many of the blue or emission-line galaxies, radio galaxies, compact objects, dwarf galaxies, interacting systems, and galaxies in which supernovae have been observed, provided always that at least *one* piece of significant information be known for the object. All galaxies listed as larger then $1'$ (inner diamter) by Vorontsov-Velyaminov or brighter then $m \cong 13$ by Zwicky were examined for possible inclusion, as were all galaxies tentatively identified with radio sources; most of the compact objects catalogued by Zwicky (1971) could not pass the diameter or magnitude rejection rule but were nevertheless included when a small redshift was indicated. Large, obscured galaxies recently found near the galactic plane were also included. All known corrections to the original BGC (G and A. de Vaucouleurs 1966, 1972; Corwin 1972) were taken into account and many additional corrections were made in the course of this revision. In particular, precise celestial coordinates of galaxy centers (Glanfield and Cameron 1967; Gallouët *et al.* 1971, 1973, 1975) were used whenever possible and radio continuum fluxes, spectral indices and 21 cm line emission data are listed for several hundred galaxies whereas none was given in the BGC. The total number of entries in this *Second Reference Catalogue of Bright Galaxies* "Revised Bright Galaxy Catalogue": RBGC) is 4364, nearly double that in the original catalogue. To avoid unnecessary duplication, the individual descriptions and bibliography given in the notes to the present catalogue do not repeat those already given in the BGC unless to correct errors or omissions. Except for the alphanumeric tabular data, the present catalogue should be considered as a companion volume to the original catalogue, not as a complete substitute.

Apart from the quantity of information, the major improvement of the RBGC over the original BGC is in the more rigorous definitions and greater precision of the diameters, magnitudes, and radial velocity data. Photometric diamteres and axial ratios refer to a statistically well-defined surface brightness level (25.0 mag arcsec$^{-1}$ in the B system), and for the first time metric (effective diameters are derived for several hundred galaxies. Total (asymptotic) magnitudes and color indices are now available for some 1500 galaxies from precise UBV photometry and the old, but still useful, Harvard magnitudes of the original Shapley-Ames survey (1932) have been reduced to the new system. Considerable efforts were devoted to the definition of error-free radial velocity systems independently for optical and radio (21 cm) data; both systems agree within $\pm$ 10 km s$^{-1}$ at all redshifts. Mean weighted velocities are presented for nearly 950 multiply observed galaxies and velocities in the same system for more than 1800 singly observed systems.

### 1.2 Source Reference

de Vaucouleurs, G., de Vaucouleurs, A. and Corwin Jr., H. G. 1976, "Second Reference Catalogue of Bright Galaxies," University of Texas Press, Austin.

## 2 Structure

### 2.1 Each File as a Whole

The RC2 consists of 1 file. Table 2.1 gives the file attributes that are the same no matter what computer the catalog is copied for. All records are of fixed length. A detailed description of the data file is given in the following section.

**Quotations in any of the following descriptions come from de Vaucouleurs *et al.* (1976) unless otherwise noted.**

| Second Reference Catalogue of Bright Galaxies (de Vaucouleurs *et al.* 1976) | | | | |
|---|---|---|---|---|
| File | Contents | Record Format | Record Length | Number of Records |
| 1 | RC2 Catalog | Fixed | 298 | 4364 |

Table 1: Summary Description of Catalog File

### 2.2 RC2 Catalog (File 1 of 1)

**RC2 identification** Second Reference Catalogue of Bright Galaxies identification following IAU Commission 28 (1973) recommendation.

| Bytes | Units | Suggested Format | Data |
|---|---|---|---|
| 1-8 | | A8 | RC2 identification |
| 9 | | A1 | Multiplicity flag |
| 10-11 | hr | I2 | Right ascension hours (epoch 1950.0) |
| 12-16 | min | F5.2 | Right ascension minutes |
| 17 | | A1 | Declination sign |
| 18-19 | deg | I2 | Declination degrees |
| 20-23 | arcmin | F4.1 | Declination arc minutes |
| 24-29 | deg | F6.2 | Galactic longitude ($\ell$) |
| 30-34 | deg | F5.1 | Supergalactic longitude (SGL) |
| 35-41 | | 7A1 | Revised morphological type |
| 42-43 | | A2 | Hubble sequence index (T) |
| 44 | | A1 | T value code |
| 45-48 | | A4 | Source of plate |
| 49 | | A1 | Revised morph. type author code |
| 50-56 | | A7 | Yerkes list 1 type and color class |
| 57 | | I1 | Byurkan nuclear type code |
| 58 | | A1 | Byurkan type additional info. flag |
| 59-62 | 0.1 arcmin | F4.2 | Major isophotal diameter ($\log \mathrm{D}_{25}$) |
| 63-66 | | F4.2 | Ratio, major to minor diameter ($\log \mathrm{R}_{25}$) |
| 67-70 | 0.1 arcmin | F4.2 | "Face-on" major isophotal diameter ($\log \mathrm{D}(0)_{25}$) |
| 71-74 | 0.1 arcmin | F4.2 | "Effective aperture" diameter ($\log \mathrm{A}_{\mathrm{e}}$) |
| 75 | | A1 | $\log \mathrm{A}_{\mathrm{e}}$ uncertainty flag |
| 76 | | 1X | Blank |
| 77-81 | | A5 | Other identifications |
| 82-88 | min/century | F7.2 | Centennial precession (2000.0) in R.A. |
| 89-93 | arcmin/century | F5.1 | Centennial precession (2000.0) in Dec. |
| 94-99 | deg | F6.2 | Galactic latitude (b) |
| 100-104 | deg | F5.1 | Supergalactic latitude (SGB) |
| 105-112 | | A8 | David Dunlap Observatory (DDO) type |
| 113 | | I1 | DDO luminosity class |
| 114 | | A1 | DDO lum. class uncertainty code |
| 115-117 | | F3.1 | Plate material classification weight |
| 118-124 | | A7 | Yerkes list 2 type and color class |
| 125 | | A1 | RC1 nuclear class prefix |
| 126 | | I1 | RC1 nuclear class numerical value |
| 127-128 | | A2 | RC1 nuclear class suffix |
| 129-132 | | F4.3 | Mean error of $\log \mathrm{D}_{25}$ |
| 133-136 | | F4.3 | Mean error of $\log \mathrm{R}_{25}$ |
| 137-140 | | F4.2 | Corrected $\log \mathrm{D}(0)_{25} = \log \mathrm{D}_0$ |
| 141-143 | | F3.2 | Mean error of $\log \mathrm{A}_{\mathrm{e}}$ |

| Bytes | Units | Suggested Format | Data |
|---|---|---|---|
| 144 | | 1X | Blank |
| 145-148 | | F4.1 | Harvard photographic magnitude ($m_H$) |
| 149 | | A1 | $m_H$ uncertainty flag |
| 150-154 | | F5.2 | Total (asymptotic) B magnitude ($B_T$) |
| 155 | | A1 | $B_T$ additional info. flag |
| 156-159 | mag/arcsec$^2$ | F4.1 | Mean B surface brightness ($m'_e$) |
| 160-163 | | F4.2 | Galactic extinction in B system ($A_B$) |
| 164-167 | | F4.2 | Asymptotic color index $(B-V)_T$ |
| 168 | | A1 | $(B-V)_T$ additional info. flag |
| 169-172 | | F4.2 | Asymptotic color index $(U-B)_T$ |
| 173 | | A1 | $(U-B)_T$ additional info. flag |
| 174-177 | | F4.2 | Effective aperture color index $(B-V)(A_e)$ |
| 178 | | A1 | $(U-B)(A_e)$ additional info. flag |
| 179-182 | | F4.2 | Effective aperture color index $(U-B)(A_e)$ |
| 183 | | A1 | $(U-B)(A_e)$ additional info. flag |
| 184-187 | | F4.2 | Total corrected $B-V$ color index |
| 188-191 | | F4.2 | Radio continuum flux density ($\log S_R$) |
| 192 | | A1 | Conditional code for $\log S_R$ |
| 193-196 | | F4.2 | Spectral index ($\alpha_-$) |
| 197 | | A1 | Conditional code for $\alpha_-$ |
| 198-201 | | F4.2 | Mean HI emission line flux density ($\log S_H$) |
| 202 | | A1 | Conditional code for $\log S_H$ |
| 203-207 | | F5.2 | Corrected radio index (RI) |
| 208 | | A1 | Conditional code for RI |
| 209-213 | km/sec | I5 | Observed "radial velocity" ($V = cz$) |
| 214 | | A1 | Observed V discrepancy code |
| 215-219 | | I5 | Corrected velocities ($V_o$) |
| 220-222 | | 3A1 | Special appendices codes |
| 223-224 | | 2X | Blank |
| 225-234 | | A10 | Other identifications |
| 235-239 | mag | F5.2 | Corrected Harvard photographic mag ($m_H^c$) |
| 240-242 | | F3.2 | Estimated mean error of $B_T$ |
| 243-246 | | F4.1 | Average surface brightness ($m'_{25}$) |
| 247-251 | mag | F5.2 | Corrected "face-on" magnitude ($B_T^o$) |
| 252-254 | | F3.2 | Mean error of asymptotic color index $(B-V)_T$ |
| 255-257 | | F3.2 | Mean error of asymptotic color index $(U-B)_T$ |
| 258-260 | | F3.2 | Mean error of effective color $(B-V)(A_e)$ |
| 261-263 | | F3.2 | Mean error of effective color $(U-B)(A_e)$ |
| 264-267 | | F4.2 | Total corrected $U-B$ color index corrected |

| Bytes | Units | Suggested Format | Data |
|---|---|---|---|
| 268-269 | | I2 | Number of radio continuum measurements ($N^-$) |
| 270-271 | | I2 | Number of radio meas. for weighted mean V ($N_R$) |
| 272-273 | | I2 | Number of radio continuum measurements ($N^+$) |
| 274-277 | | F4.2 | Spectral index ($\alpha_+$) |
| 278 | | A1 | Conditional code for $\alpha_+$ |
| 279 | | I1 | Number of 21 cm emission line observations ($n_H$) |
| 280-282 | | F3.2 | Self-absorption at 21 cm ($A_{21}$) |
| 283-287 | | F5.2 | Neutral hydrogen index (HI) |
| 288 | | A1 | Conditional code for HI |
| 289 | | I1 | Number of radio observations for computing V ($N_R$) |
| 290-291 | | I2 | Number of optical observations for computing V ($N_O$) |
| 292-294 | | I3 | Mean error of mean radial velocity ($me_V$) |
| 295-298 | | I4 | Solar motion correction ($\Delta V$) |

**Multiciplicity flag** Anonymous objects close to NGC or IC objects and previously designated by the same numbers followed by A, B, C, etc. have been retained. If a decimal point appears in this byte this indicates double or multiple objects-the listed data then refers to the combined objects but the classification refers to the brightest component. (It occurs in byte 8 for the IC Identification only).

**Galactic coordinates** Galactic longitude and latitude in IAU 1958 system (longitude appears in bytes 24-29 and latitude appears in bytes 94-99).

**Supergalactic coordinates** SGL and SGB are in a slightly revised system with the same North pole at $\ell = 47\overset{\circ}{.}37$, $b = +6\overset{\circ}{.}32$ but the SGL origin at $\ell = 137\overset{\circ}{.}39$, $b = 0°$ (instead of $\ell^I = 105°, b^I = 0°$) to conform with the new galactic equator. The revised SGL is about 0.7 degrees greater than the old one.

**Revised morphological type** As given in the *Handbuch der Physik* system. These types are coded as given in Table 2 (which is from the introduction to the published catalogue). The number of symbols used gives an indication of the degree of resolution available and of the reliability of the classification.

**Hubble sequence index** Numerical index (T) of stage along the Hubble sequence (this index is defined by Heidmann, Heidmann and de Vaucouleurs 1971; de Vaucouleurs 1974) with the few exceptions as stated in the preface to the published catalogue.

Hubble types by Rood & Baum 1967, Nilson 1973, and Holmberg et al. 1974 have been converted to revised system as given in Table 3.

**T value code blank** default

**R** there is a note

**$** doubtful

* uncertain

**Source of plate** See Table 4.

**Morph. type author code** See Table 5.

**Yerkes type and color class** Yerkes list 1 types and color classes (Mt. Wilson-Palomar reflector plates; Morgan 1958) are given for 608 galaxies (13.9% of catalogues objects). Yerkes list 2 types and color classes (48 inch Palomar-Schmidt plates, Morgan 1959) are given for 645 galaxies (14.8% of catalogued objects). These values are coded as given in Table 6.

**Byurkan nuclear type** Nuclear types in Byurakan system (Kalloglian and Tovmassian 1964; Tovmassian 1965, 1966 and 1967) values are given for 516 galaxies. Byte 57 (format I1) contains a numerical value on a scale from 1 to 5:

**1** no central condensation

**2** weak central condensation

**3** strong central condensation but no star-like image

**4** star-like nuclear image at short exposure but nebulous at long exposure

**5** star-like nuclear image even at long exposures

Byte 58 contains an additional information flag:

**blank** default

***** uncertain

**S** small nucleus

When two independent classifications differ both are given – the first in byte 57 and the second in byte 58.

**Major isophotal diameter** $\log_{10} \mathrm{D}_{25}$ is the logarithm of the apparent major isophotal diameter measured at or reduced to surface brightness level $\mu_{\mathrm{B}} = 25.0 \mathrm{mag\ sec}^{-2}$ (about one-tenth of the night sky brightness), (unit of D is 0.1 arcmin to avoid negative entries). The user is advised to refer to the published catalogue for the details of the reduction formula from the input source data to the standardized $\log \mathrm{D}_{25}$ system given. There are 3872 objects (88.7% of the catalogue) for which a $\log \mathrm{D}_{25}$ value is given.

**Ratio major to minor diameter** $\log_{10} \mathrm{R}_{25}$ is the logarithm of the ratio of major diameter $\mathrm{D}_{25}$ to minor diameter $\mathrm{d}_{25}$ measured at or reduced to surface brightness level $\mu_{\mathrm{B}} = 25.0$ mag $\mathrm{sec}^{-2}$. (Same remarks as for **major isophotal diameter** above.) There are 3871 objects (88.7% of the catalogue) for which a $\log \mathrm{R}_{25}$ value is given.

**"Face-on" major isophotal diameter** $\log_{10} \mathrm{D}(0)_{25}$ is the logarithm of the isophotal major diameter statistically converted to "face-on" ($i = 0°$) by the relation:

$$\log \mathrm{D}(0)_{25} = \log \mathrm{D}_{25} - 0.235 \log \mathrm{R}_{25}$$

irrespective of type.

**“Effective aperture” diameter** $\log_{10} A_e$ is the logarithm of the apparent diameter of the “effective aperture”, being the smallest *circle* (generally centered at the nucleus) within which half of the total B-band flux is emitted.

$A_e$ **uncertainty flag** An asterisk (*) is given in this byte for uncertain values of $\log A_e$ (and no value is given for $\log A_e$). A dollar sign ($) means that the given value of $\log A_e$ is doubtful.

**Other identifications** Coded as follows:

- **Mknnn** Markarian’s lists of blue objects (1967-1974)
- **Dnnn** van den Bergh’s (1959, 1966) catalogue of DDO dwarf galaxies
- **1Znnn** to
- **7Znnn** Zwicky’s seven lists of compact galaxies (1961-1968, 1971)
- **ZCG** Zwicky’s Catalogue of Selected Compact Galaxies (1971)
- **Vnnn** Vorontsov-Velyaminov’s Atlas and Catalogue of Interacting Galaxies (1959)

**David Dunlap Observatory (DDO) type** DDO types and luminosity classes esimated by van den Bergh (1960) on Palomar Sky Survey plates are coded as in Table 7. DDO types are given for 1256 galaxies (28.8% of the cataloged objects; 1012 are in Luminosity classes are given for 711 (16.3catalogued objects) galaxies (489 are in Shapley-Ames).

The uncertainty code defaults to blank, “*” means uncertain, and “$” means doubtful.

**Plate material classification weight** On a scale of approximately $1-5$ calculated as follows:

$$W = \log N \cong 2 \log A + (2 \log D - \log R)$$

where:

$N$ = number of resolution elements in the galaxy image which in a first approximation is proportional to the square of the telescope aperture and to the image area, i.e. $N \propto A^2(D \times d)$
$A$ = telescope aperture in meters
$D = D_{25}$ in 0.1 arcmin units
$R = D/d$ is the axis ratio

The user should refer to the published catalogue for the explicit details about other qualifications on this scheme.

**RC1 nuclear class** Nuclear class from the description in the Bright Galaxy Catalogue notes. A prefix “D” in byte 125 stands for diffuse nucleus, otherwise this byte is blank. A numerical scale from 1 to 5 is given in byte 126, meaning:

- **1** No definite nucleus
- **2** Nucleus of average brightness
- **3** Bright nucleus
- **4** Very bright nucleus

**5** Extremely bright nucleus

A suffix in bytes 127-128 of " L", " S", "VS", and "ES" stand for large, small, very small and extremely small nucleus, respectively. Otherwise bytes 127-128 are blank.

**Mean error of** $\log \mathrm{D}_{25}$ Given by:

$$\sigma_{\mathrm{w}}(\log \mathrm{D}_{25}) = 0.1/\mathrm{w}^{1/2} = 0.1/(\sum \mathrm{w_i})^{1/2}$$

where $w_i$ are the individual catalogue weights. For 3872 objects, the average mean error is 0.04 (range 0.32 to 0.02). For 348 objects the mean error is in excess of 0.1 and should be regarded as tentative only.

**Mean error of** $\log \mathrm{R}_{25}$ Given by:

$$\sigma(\log \mathrm{R}_{25}) = 0.10/(\sum \mathrm{w_i})^{1/2}$$

where $w_i$ are the individual catalogue weights. For 3871 objects the average mean error is 0.04 (range 0.18 to 0.013). For 398 galaxies the mean error is in excess of 0.1 and should be regarded as tentative only.

**Corrected** $\log \mathrm{D}(0)_{25}$ $\log_{10} \mathrm{D}_0 = \log \mathrm{D}(0)_{25}$ statistically corrected for galactic extinction to $A_B = 0$ by the interpolation relation:

$$\log \mathrm{D}_0 = \log \mathrm{D}(0)_{25} + (0.12 - 0.007\mathrm{T})\mathrm{A_B}$$

where $\mathrm{A_B}$ is the B-band extinction in magnitudes (see **Galactic extinction in B system** below).

**Mean error of** $\log \mathrm{A_e}$ The details of the calculation of this value are too detailed for this document. The reader is advised to consult the published version of the catalogue.

**Harvard photographic magnitude** ($\mathrm{m_H}$) The apparent photographic magnitude for all objects listed in *Harvard Annals*, 88, 2. This field identifies objects listed in the original Shapley-Ames Catalogue. Uncertain values are noted by an asterisk (*) in the **$\mathbf{m_H}$ uncertainty flag**.

**Total (asymptotic) B magnitude ($\mathbf{B}_T$)** Detailed photographic surface photometry with photoelectric zero point calibration and reaching to light levels ($\approx 1\%$ of night sky) has been performed on a number of galaxies sufficient to define a standard system of total (or more exactly asymptotic) magnitudes. To avoid excessive extrapolations only galaxies observed with an aperture greater than a finite limit were used. An asterisk (*) in byte 155 indicates that no total magnitude could be derived with single aperture observations requiring corrections in excess of 0.5 mag. An "S" in byte 155 indicates that the value of $B_T$ is a weighted mean.

Total magnitudes ($B_T$) are given for 1340 (30.7% of catalogues objects) galaxies (817 are in Shapley-Ames); 1015 are from multiple-aperture observations and/or surface photometry, and 325 are from single-aperture photometry. The user of the catalogue should refer to the published catalogue for the lengthy details on the $B_T$ computation.

**Mean B surface brightness** ($m'_e$) Measured within the effective aperture $A_e$ and defined as:

$$m'_e = (m_T + 0.75) + 5 \log A_e - 5.26$$

where $m'_e$ is in mag arcmin$^{-2}$ when $A_e$ is in *tenths* of arc minutes and $m_T = B_T$ (bytes 150-154) or $m^c_H$ (bytes 235-239).

**Galactic extinction in B system** ($A_B$) Calculated by the relations:

$$\begin{aligned} A_B &= 0.19[1 + S_N(\ell) \cos b]|C| \qquad (b > 0) \\ A_B &= 0.21[1 + S_S(\ell) \cos b]|C| \qquad (b < 0) \end{aligned}$$

where $\ell$, b are the galactic coordinates and:

$$\begin{aligned} S_N(\ell) = \; & 0.1948 \cos \ell + 0.0725 \sin \ell + \\ & 0.0953 \cos 2\ell - 0.0751 \sin 2\ell + \\ & 0.0936 \cos 3\ell + 0.0639 \sin 3\ell + \\ & 0.0391 \cos 4\ell + 0.0691 \sin 4\ell \end{aligned}$$

$$\begin{aligned} S_S(\ell) = \; & 0.1749 \cos \ell - 0.0112 \sin \ell + \\ & 0.1438 \cos 2\ell - 0.0180 \sin 2\ell - \\ & 0.0897 \cos 3\ell - 0.0013 \sin 3\ell + \\ & 0.0568 \cos 4\ell + 0.0433 \sin 4\ell \end{aligned}$$

and $C = \csc(b + 0.^{\circ}25 - 1.^{\circ}7 \sin \ell - 1.^{\circ}0 \cos 3\ell)$

Best current estimates of the total B extinction is $A_B = 0.19$ mag at the North galactic pole and $A_B = 0.21$ mag at the South galactic pole.

**Asymptotic color index** $(B - V)_T$ Total $(B - V)_T$ color index from multiple-aperture data are given for 959 (21.9% of catalogued objects) galaxies; there are 394 galaxies with values of the $(B - V)_T$ color index from sinqle-aperture observations. In all, 1260 values are given for 29.1% of the catalogued galaxies (of which 761 are Shapley-Ames objects). An asterisk (*) in byte 168 indicates that no total magnitude could be derived with single aperture observations requiring corrections in excess of 0.5 mag.

**Asymptotic color index** $(U - B)_T$ Total $(U - B)_T$ color index from multiple-aperture data are given for 682 (15.6% of the catalogued objects) galaxies; there are 130 galaxies with values of the $(U - B)_T$ color index from single-aperture observations. In all 811 values of $(U - B)_T$ are given for 18.9% of the catalogued galaxies (of which 494 are Shapley-Ames objects). An asterisk (*) in byte 173 indicates that no total magnitude could be derived with single aperture observations requiring corrections in excess of 0.5 mag.

**Effective aperture color index** $(\mathrm{B}-\mathrm{V})(\mathrm{A_e})$ interpolated among the *observed* (B-V) color index measurments at the **effective aperture** ($\mathrm{A_e}$ bytes 71-74). There are 751 galaxies (of which 520 are in Shapley-Ames) or 17.2% of the catalogue with values given. An asterisk (*) in byte 178 indicates that not enough color index measurements exist to derive the effective color index.

**Effective aperture color index** $(\mathrm{U}-\mathrm{B})(\mathrm{A_e})$ interpolated among the *observed* (U-B) color index measurments at the **effective aperture** ($\mathrm{A_e}$, bytes 71-74). There are 668 galaxies (of which 478 are in Shapley-Ames) or 15.3% of the catalogue with values given. An asterisk (*) byte 178 indicates that not enough color index measurements exist to derive the effective color index.

**Total $B-V$ color index** Corrected for galactic and internal absorption and for redshift; *i.e.*, corrected "face-on" color index $(\mathrm{B}-\mathrm{V})^{\mathrm{o}}_{\mathrm{T}}$. The details of this computation are too lengthy for this document so that the reader is advised to refer to the published catalogue for details.

**Radio continuum flux density ($\log \mathrm{S_R}$)** $\mathrm{Log}_{10}$ of radio continuum flux density ($\mathrm{S_R}$) at or near the standard frequency $\nu_R = 1400$ MHz in 0.01 Jansky units ($= 10^{-28}\mathrm{Wm^{-2}Hz^{-1}}$) to avoid negative entries. The values given here are the unweighted averages of all available measurements in the 1400 to 1420 MHz range. The number of observations in this range is $\mathrm{N_R}$ and is given in bytes 270-271. A total of 270 values of log $\mathrm{S_R}$ are given (6.2% of the catalogue).

**Conditional code for $\log \mathbf{S_R}$** Default is blank:

- **$** If no data exist at 1400 MHz but observations are available at both lower and higher frequencies, an approximate value of log $\mathrm{S_R}$ was derived by linear interpolation from the best fit curve in the log $\mathrm{S_R}$ vs. log $\nu$ data. A value of $\mathrm{N_R} = 0$ (bytes 270-271) was assigned-for these cases.
- * This case is if $\mathrm{N_R} \geq 1$ (bytes 270-271) but an uncertain $\mathrm{S_R}$ due to unusually large scatter or very low flux ($\mathrm{S_R} < 0.05$ Jy were rejected).
- \+ When a close pair was in the beam, the flux is entered under the optically brighter or larger galaxy and a plus sign is entered both after that value and in the same byte with no value given for log $\mathrm{S_R}$ (bytes 188-191) for the secondary object.

**Spectral Index ($\alpha_-$)** The slope of the best fitting straight line ($\alpha_-$ for $\nu < \nu_\mathrm{R}$, see note in **radio continuum flux density**) approximating the radio spectral energy distribution in the log S vs. log $\nu$ diagram, *i.e.*, the coefficient $\alpha$ in:

$$\log(\mathrm{S}/\mathrm{S_R}) = -\alpha \log(\nu/\nu_\mathrm{R}).$$

The spectral index $\alpha_-$ is given for 253 galaxies from 1080 observations at $\nu < \nu_\mathrm{R}$. The number of observations used in each interval for each galaxy is the value of $\mathrm{N}_-$ given in bytes 268-269.

A conditional code for $\alpha_-$ is given in byte 197 for when the representation of the spectral energy curve by two straight lines is not good (blank is the default):

* Uncertain values

**\$** Very uncertain values

**Mean HI emission line flux density** ($\log S_H$) The values given here are the unweighted averages of all non-rejected independent measurements in units of $10^{-22}$W$\mathrm{m}^{-2}$. The number of observations used in this average is $n_H$ and is given in byte 279. The relation between the 21 cm emission line flux density $F_H$ and $S_H$ is:

$$\log F_H = \log S_H - 0.304$$

where $F_H$ is in units of $10^6$ solar masses per Mpc$^2$ so the apparent total mass of neutral hydrogen ($m_H$) in a galaxy is given in solar units by:

$$\begin{aligned}\log(M_H/M_\odot) &= \log F_H + 2\log\Delta + 6 \\ &= \log S_H + 2\log\Delta + 5.696\end{aligned}$$

where $\Delta$ is the distance to the galaxy in megaparsecs (Mpc). Values of $S_H$ are derived from a total of 632 observations and are given for 474 galaxies (10.9% of the catalogue).

**Conditional code for** $\log S_H$ Default is blank:

**\$** A dollar sign in this byte indicates unresolved discrepancies in excess of 0.2 in $\log S_H$ (bytes 198-201) between independent observations or the existence of marginal detection.

**+** When two nearby galaxies were in the antenna beam, the flux was assigned to the brighter one and a plus sign is given both in this byte and in the same byte with no value given for $\log S_H$ (bytes 198-201) for the secondary object.

* This case is if $n_H \leq 1$ (byte 279) but an uncertain $S_H$ (bytes 198-201) due to unusually large scatter or very low flux.

**Corrected radio index (RI)** Defined as:

$$RI = m_R^o - B_T^o$$

where $B_T^o$ is the **corrected face-on magnitude** and $m_R^o$ is the radio magnitude corrected for the effect of redshift

$$\begin{aligned}m_R^o &= m_R - 2.5(\alpha - 1)\log(1+z) & (z > 0.04) \\ m_R^o &= m_R - 3.63\cdot 10^{-6}(\alpha_R - 1)\cdot cz & (z < 0.04)\end{aligned}$$

where

$$\begin{aligned}m_R &= 11.6 - 2.5\log(S_R/100); \\ \alpha_R &= (\alpha_+ + \alpha_-)/2;\end{aligned}$$

and cz is the radial velocity in km s$^{-1}$

| Quantity | Bytes |
|---|---|
| $S_R$ | 188-191 |
| $\alpha_-$ | 193-196 |
| $\alpha_+$ | 274-277 |
| cz = V | 209-213 |

The **corrected radio index** is given for 174 galaxies or 65% of those for which the value of $\log S_R$ is given. The radio indices range from about $-4.2$ for the brightest radio galaxies (3C88, 3C75, N7236-37) to about $+5.0$ for the weakest detected galaxies (N55, N598, N3368).

**Conditional code for RI** Blank is the default, "$" means that the radio index is doubtful.

**Observed "radial velocity" (V = cz)** The weighted mean of all optical and radio observations corrected for systematic errors.

A total of 3433 optical redshifts were combined to derive the observed (heliocentric), weighted mean velocities of 2502 galaxies. A total of 810 radio redshifts were combined to derive the observed weighted mean velocities of 618 galaxies. A total of 2713 velocities (62.2% of the catalogue) are given of which 911 are means of two or more observations and 1802 are from single observations all reduced to the same mean system.

The reader should refer to the published catalogue for the multitude of details for the reduction of the data to a uniform system.

**Observed V discrepancy code** An asterisk ("*") in this byte identifies the 95 galaxies with discrepant optical velocities (range $\geq 200$ km/s) and the 51 galaxies with $\delta V$ (optical – radio) $\geq 100$ km/s. Only three galaxies are in common (N520, N2613, and I2184). Thus there are 143 objects with an asterisk; all other entries have the default blank in this byte.

**Corrected velocities** ($V_o$) Defined as:

$$V_o = V + \Delta V$$

where $\Delta V = 300 \cos A = 300 \sin \ell \cos b$ (**solar motion correction**) was calculated for a solar apex at $\ell = 90°, b = 0°$.

Corrected velocities are given for 2713 galaxies; only 15 are negative (smallest IC3258, $V_o = -517$ km/s) and 13 are in excess of 14,000 km/s (largest A1855+37, $V_o = +16828$ km/s).

**Special appendices codes** Codes for entries that have entries in the special appendices in the published catalogue (default is blank):

| Byte | Code | Meaning |
|---|---|---|
| 220 | P | source of photographs in 18 atlases and major surveys |
| 221 | S | galaxies with supernovae |
| 222 | T | Hubble-Sandage and Hubble-Holmberg types |

**Other identifications** Zwicky's seven lists of compact galaxies and Zwicky's Catalogue of Selected Compact Galaxies or in Vorontsov-Velyaminov's Atlas and Catalogue of Interacting Galaxies (1959). (See also bytes 77-81)

**Corrected Harvard photographic mag ($m_H^c$)** Harvard photographic magnitude statistically corrected to the $B_T$ system ($m_H^c$) where:

$$m_H^c = m_H + a + b(m_H - 12.0) + c(m'_H - \mu') + d(\log R_{25})^2$$

where $m'_H = m_H + 5\log D_{25} - 2.5\log R_{25} - 5.26$
is a measure of the average surface brightness (mean value $\mu'$) and the constants a to d are as a function of galaxy type as follows:

| | | | | |
|---|---|---|---|---|
| a | $-0.35$ | for $T \leq -3$ | $-0.25$ | for $T > -3$ |
| b | $+0.12$ | for $T \leq +5$ | $+0.12 - 0.02(T-5)$ | for $T < +5$ |
| c | $-0.46$ | for $T \leq +5$ | $-0.46 + 0.06(T-5)$ | for $T \geq +5$ |
| d | $-2.50$ | for $T \leq -4$ | $-0.50 + 0.05T$ | for $T \geq -3$ |
| $\mu'$ | 14.05 | for $T < 0$ | 14.25 | for $T \geq 0$ |

Corrected Harvard magnitudes are given for 1237 objects or 99.0% of the Shapley-Ames galaxies and 28.3% of the catalogued objects.

**Estimated mean error of** $B_T$

$$\begin{aligned}
\sigma_n(B_T) &= \sigma_1/(\sqrt{n}) \\
\sigma_1 &= 0.13 \text{ mag independent of type} \\
n &= \text{number of observations (range 1 to 17,} \\
&\quad\ \text{with } \overline{n} \approx 3) \\
\sigma(B_T) &= 0.14 \text{ mag for 118 standard galaxies}
\end{aligned}$$

The average mean error is 0.09 mag (range 0.20 mag to 0.03 mag) for the 1340 galaxies that have given values of $B_T$.

**Average surface brightness ($m'_{25}$)** The average surface brightness within the ellipse of major axis $D_{25}$ (bytes 59-62) and axis ratio $R_{25}$ (bytes 63-66) is defined by:

$$m'_{25} = (m_T + \Delta m_{25}) + 5\log D_{25} - 2.5\log R_{25} - 5.26$$

where $\Delta m_{25} = B_{25} - B_T$ is the magnitude increment contributed by the outer regions of a galaxy fainter than $\mu_B = 25.0$ mag sec$^{-2}$ ($B_T$ is given in bytes 150-154 and $m_T = B_T$ or $m_H^c$ in bytes 235-239) The average corrections derived for different types are:

| | E | L | SO/a to $I_m$ |
|---|---|---|---|
| $\Delta B_{25}$ | 0.25 mag | 0.13 mag | 0.11 mag |

Values for $m'_{25}$ are given for 1692 galaxies (38.8% of the catalogued objects; 1237 are in Shapley-Ames, where most are in the range 12 to 16 $B$ magnitudes per arc minute$^2$.

**Corrected "face-on" magnitude** ($B_T^o$) The magnitude corrected for galactic extinction, internal extinction and redshift.

$$\begin{aligned} B_T^o &\equiv B_T(A_B = 0, i = 0, z = 0) \\ B_T^o &= B_T - A_B - A(i) - K'_B(T) \cdot cz \end{aligned}$$

The internal extinction in the B system is:

$$A(i) = 0.72 \log \sec i$$

but the inclination (i) is not known for most galaxies. Empirically:

$$A(i) = \alpha(T) \log R_{25}$$

where:

$$\begin{array}{lll} \alpha(T) & = 0 & \text{for } T \leq -4 \\ & = 0.2\ (T+4) & \text{for } -3 \leq T \leq -1 \\ & = 0.7 & \text{for } T = 0 \\ & = 0.8 & \text{for } 1 \leq T \leq 8 \\ & = 0.1\ T & \text{for } T \geq 8 \end{array}$$

and values of log $R_{25}$ are given in bytes 63-66. For small redshifts the following linear approximation is sufficient:

$$K_B(z, T) = K_B(T) \cdot z = K'_B(T) \cdot cz$$

where cz = observed (heliocentric) velocity in km/s (bytes 209-213):

$$\begin{array}{lll} 10^4 \cdot K'_B(T) & = 0.15 & \text{for } T \leq 0 \\ & = 0.15 - 0.025T & \text{for } 0 \leq T \leq 3 \\ & = 0.075 - 0.010\ (T - 3) & \text{for } T \geq 3 \end{array}$$

The values of $B_T$ and A are given in bytes 150-154 and 160-163 respectively.

Corrected total magnitudes ($B_T^o$) are given for 1011 objects (23.2% of the catalogue; 697 are in Shapley-Ames).

**Mean error of asymptotic color index** $(B-V)_T$ Mean error $[\sigma(C_T)]$ of the **asymptotic color index** $C_T = (B-V)_T$ (bytes 164-167) is given as a function of the value of T (bytes 42-43):

$$\sigma(C_T) = \sigma_1(T)/\sqrt{n_T}$$

where $n_T$ is the number of observations.

| | | | | |
|---|---|---|---|---|
| T | −6 to −1 | 0, 1 | 2 to 8 | 9, 10 |
| $\sigma_1$ | 0.05 mag | 0.04 mag | 0.05 mag | 0.04 mag |

The average mean error is 0.03 mag (range 0.10 to 0.01 mag).

**Mean error of asymptotic color index** $(\mathrm{U}-\mathrm{B})_\mathrm{T}$ Mean error ($\sigma$) of the **asymptotic color index** $\mathrm{C_T} = (\mathrm{U}-\mathrm{B})_\mathrm{T}$ (bytes 169-172) is given as a function of the value of T (bytes 42-43):

$$\sigma(\mathrm{C_T}) = \sigma_1(\mathrm{T})/\sqrt{\mathrm{n_T}}$$

where $\mathrm{n_T}$ is the number of observations.

| | | | | |
|---|---|---|---|---|
| T | −6 to −1 | 0, 1 | 2 to 8 | 9, 10 |
| $\sigma_1$ | 0.06 mag | 0.05 mag | 0.05 mag | 0.05 mag |

The average mean error is 0.04 mag (range 0.10 to 0.02 mag).

**Mean error of effective color** $(\mathrm{B}-\mathrm{V})(\mathrm{A_e})$ Mean error $[\sigma(\mathrm{C_e})]$ of the **effective aperture color** $\mathrm{C_e} = (B-V)(\mathrm{A_e})$ (bytes 174-177) is given as a function of the value of T (bytes 42-43):

$$\sigma(\mathrm{C_e}) = \sigma_1(\mathrm{T})/\sqrt{\mathrm{n_e}}$$

where $\mathrm{n_e}$ is the number of observations.

| | | | | | |
|---|---|---|---|---|---|
| T | −5 to −1 | 0, 1 | 2 to 5 | 6 to 8 | 9, 10 |
| $\sigma_1$ | 0.05 mag | 0.05 mag | 0.06 mag | 0.05 mag | 0.04 mag |

The average mean error is 0.03 mag (range 0.10 to 0.01 mag).

**Mean error of effective color** $(\mathrm{U}-\mathrm{B})(\mathrm{A_e})$ Mean error $[\sigma(\mathrm{C_e})]$ of the effective color $\mathrm{C_e} = (\mathrm{U}-\mathrm{B})(\mathrm{A_e})$ (bytes 179-182) is given as a function of the value of T (bytes 42-43):

$$\sigma(\mathrm{C_e}) = \sigma_1(\mathrm{T})/\sqrt{\mathrm{n_e}}$$

where $\mathrm{n_e}$ is the number of observations.

| | | | | | |
|---|---|---|---|---|---|
| T | −5 to −1 | 0, 1 | 2 to 5 | 6 to 8 | 9, 10 |
| $\sigma_1$ | 0.06 mag | 0.05 mag | 0.05 mag | 0.05 mag | 0.05 mag |

The average mean error is 0.04 mag (range 0.10 to 0.01 mag).

**Total corrected U-B color index corrected** Total U-B color index corrected for galactic and internal absorption and for redshift; *i.e.* corrected "face-on" color index $(\mathrm{U}-\mathrm{B})^\mathrm{o}_\mathrm{T}$. The details of this computation are too lengthy for this document so that the reader is advised to refer to the published cata- logue for details.

**Number of radio continuum measurements** ($N^-$) The number measurements available at $\nu < \nu_R$ (bytes 188-191 and 193-196).

**Number of radio meas. for weighted mean** ($N_R$) The number of radio measurements at the "standard" frequency $\nu_R$ used to derive $S_R$ (bytes 209-213).

**Number of radio continuum measurements** ($N^+$) The number of measurements available at $\nu > \nu_R$ (bytes 188-191 and 274-277)

**Spectral index** ($\alpha_+$) The slope of the best fitting straight line ($\alpha_+$ for $\nu > \nu_R$, see note in **radio continuum flux density**) approximating the radio spectral energy distribution in the log S vs. log $\nu$ diagram, *i.e.*, the coefficient $\alpha$ in:

$$\log(S/S_R) = -\alpha \log(\nu/\nu_R).$$

The spectral index $\alpha_+$ is given for 239 galaxies from 880 observations at $\nu > \nu_R$. The number of observations used in each interval for each galaxy is the value of $N^+$ given in bytes 272-273.

A conditional code for $\alpha_+$ is given in byte 278 for when the representation of the spectral energy curve by two straight lines is not good (blank is the default):

* Uncertain values

**$** Very uncertain values

**Number of 21 cm emission line observations** ($N_H$) The number of 21 cm emission line integrated flux observations used to derive $S_H$ (bytes 198-201).

**Self-absorption at 21 cm** ($A_{21}$) The self-absorption at 21 cm is used in the definition of the 21 cm line magnitude corrected for self-absorption ($n^o_{21}$) which is used in the definition of the **neutral hydrogen index** (HI).

$$A_{21}(i) = \log \kappa/(1 - e^{-\kappa})$$

where i is the inclination and $\kappa$ is the effective optical depth defined as:

$$\kappa = 0.031/\cos i$$

**Neutral hydrogen index (HI)** Defined as:

$$HI = m^o_{21} - B^o_T$$

where $m^o_{21}$, is the 21 cm line magnitude corrected for self-absorption and is defined as:

$$m^o_{21} = 16.6 - 2.5 \log S_H - 2.5 A_{21}(i)$$

where $S_H$ is the **mean HI emission line flux density** (bytes 198-201) and $A_{21}(i)$ is the self-absorption at inclination i (bytes 280-282). The quantity $B_T^o$ is the **corrected "face-on" magnitude** (bytes 247-251).

The hydrogen to continuum radio index is calculated as follows:

$$HR = HI - RI$$

where RI is the **corrected radio index** (bytes 203-207) and HI is the neutral hydrogen index given above.

Values of HI are given for 240 galaxies, of which 62 also have a radio index.

A conditional code for HI is given in byte 288; the default is blank, "$" means that HI is doubtful.

**Number of radio observations for computing V** ($N_R$) The number of radio observations used in computing the mean radial velocity (bytes 209-213).

**Number of optical observations for computing V** ($N_O$) The number of optical observations used in computing the mean radial velocity (bytes 209-213).

**Mean error of mean radial velocity** ($me_V$) Mean error of the mean radial velocity (bytes 209-213) in km/s. The average mean error of the mean radial velocities is 67 km/s (range 3 to 300).

**Solar motion correction** ($\Delta V$) The solar motion correction to the mean radial velocities in km/s.

$$\Delta V = 300 \cos A = 300 \sin \ell \cos b$$

where $\ell$, b are the galactic coordinates. This quantity is used to compute the corrected radial velocities ($V_o$, bytes 215-219).

# 3 History

The machine-readable version (magnetic tape) of the Second Reference Catalogue of Bright Galaxies was received at NASA/GSFC in 1980. The introduction to this catalogue is extremely informative and explicit in detail. The information given in this document has been gleaned from the introduction and presented in a fashion that would be of the maximum benefit to users of the machine-readable version. There are many derived quantities in the catalogue and the user of the catalogue is urged to refer to the published catalogue for a more detailed description of the particulars of these quantities. To facilitate usage of the machine-readable version, several of the tables that are given in the published catalogue are also given for convenience in the sections following.

The only manipulation of the data was that the sign byte of the declination used to be either byte 17 or 18 (only the negative sign is explicit) and now it is always in byte 17.

| Classes | Families | Varieties | Stages | T | Type | Code |
|---|---|---|---|---|---|---|
| Ellipticals | | Compact | | −6 | cE | cE... |
| | | | Ellipt. (0–6) | −5 | E0 | .E.0. |
| | | | Intermediate | −5 | E0–1 | .E.0+ |
| | | “cD” | | −4 | E+ | .E$^+$.. |
| Lenticulars | | | | | S0 | .L |
| | Non-barred | | | | SA0 | .LA |
| | Barred | | | | SB0 | .LB |
| | Mixed | | | | SAB0 | .LX |
| | | Inner ring | | | S(r)0 | .L.R |
| | | S-shaped | | | S(s)0 | .L.S |
| | | Mixed | | | S(rs)0 | .L.T |
| | | | Early | −3 | S0$^-$ | .L..− |
| | | | Intermediate | −2 | S0$^\circ$ | .L..0 |
| | | | Late | −1 | S0$^+$ | .L..+ |
| Spirals | Non-barred | | | | SA | .SA |
| | Barred | | | | SB | .SB |
| | Mixed | | | | SAB | .SX |
| | | Inner ring | | | S(r) | .S.R |
| | | S-shaped | | | S(s) | .S.S |
| | | Mixed | | | S(rs) | .S.T |
| | | | 0/a | 0 | S0/a | .S..0 |
| | | | a | 1 | Sa | .S..1 |
| | | | ab | 2 | Sab | .S..2 |
| | | | b | 3 | Sb | .S..3 |
| | | | bc | 4 | Sbc | .S..4 |
| | | | c | 5 | Sc | .S..5 |
| | | | cd | 6 | Scd | .S..6 |
| | | | d | 7 | Sd | .S..7 |
| | | | dm | 8 | Sdm | .S..8 |
| | | | m | 9 | Sm | .S..9 |
| Irregulars | Non-barred | | | | IA | .IA |
| | Barred | | | | IB | .IB |
| | Mixed | | | | IAB | .IX |
| | | S-shaped | | | I(s) | .I.S |
| | | | Non-Magellanic | 90 | I0 | .I.0 |
| | | | Magellanic | 10 | Im | .I..9 |
| | | Compact | | 11 | cI | cI |
| Peculiars | | | | 99 | Pec | .P |
| Peculiarities | | | Peculiarity | | pec | .....P |
| (All types) | | | Uncertain | | : | ....* |
| | | | Doubtful | | ? | ....? |
| | | | Spindle | | sp |...../ |
| | | | Outer ring | | (R) | R...... |
| | | | Pseudo-outer R | | (R$'$) | P...... |

Table 2: Coding of revised morphological types

| Hubble | Revised | T |
|---|---|---|
| E | E | -5 |
| E-S0 | L-: | -3: |
| S0 | L | -2 |
| IrrII | I0 | 0: |
| S0/a | S0/a | 0 |
| Sa | Sa | 1 |
| Sa-b | Sab | 2 |
| Sb | Sb | 3 |
| Sb-c | Sbc | 4 |
| Sc | Scd: | 6: |
| Sc-Irr | Sdm: | 8: |
| IrrI | Im | 10 |
| S... | S. | 3? |
| S“early” | S.(Sa?) | 1? |
| S“late” | S.Sc? | 5? |

Table 3: Conversion of Hubble Types to Revised System

| Observatory | Tel. Ap. (in.) | Code | Observatory | Tel. Ap. (in.) | Code |
|---|---|---|---|---|---|
| Palomar | 200 | P200. | Mt. Wilson | 60 | W060. |
| Lick | 120 | L120. | Tautenburg | 52 | T052. |
| Mt. Wilson | 100 | W100. | Palomar (prints) | 48 | P048. |
| McDonald | 82 | M082. | Palomar (glass) | 48 | PG48. |
| Radcliffe | 74 | R074. | ESO | 40 | E040. |
| Mt. Stromlo | 74 | S074. | Siding Spring | 40 | S040. |
| USNO (Flagstaff) | 61 | N061. | Lick | 36 | L036. |
| Boyden | 60 | B060. | Mt. Stromlo | 30 | S030. |
| Cordoba | 60 | C060. | | | |

Table 4: Codes for telescope sources of revised types

| Code | Reference |
|---|---|
| ....B | Buta, R., Publ. Warner and Swasey Obs., II, in press, 1976 |
| ....C | Corwin, H. G., Publ. Dept. Astr. U. Texas, II, 2, No. 12, 1968; II, 3, No. 5, 1970; PASP, 83, 320, 1971; unpublished 1971-1975. |
| ....F | Fisher, J. R., and Tully, R. B., A&A, 44, 151, 1975 |
| ....H | Holmberg, E., et al., A&AS, 18, 463 and 491, 1974 |
| ....N | Nilson, P., UGC, 1973; Uppsala Obs. Rep. No. 5, 1974 |
| ....R | Rood, H. J., and Baum, W. A., AJ, 72, 398, 1967 |
| ....V | de Vaucouleurs, G., ApJS, No. 74, 1963; RC1, 1964; unpublished 1964-1975. |

Table 5: Codes for author sources of revised types

| Classes | Type | Code | Classes | Type | Code |
|---|---|---|---|---|---|
| Elliptical | E(0-7) | E0 | Irregular | I | I |
| | E-D | ED | | S-I | SI |
| | D-E | DE | | I-S | IS |
| | S-E | SE | | I-B | IB |
| Dusty | | D | | B-I | BI |
| | D-S | DS | Peculiarities | L(1) | ..L |
| | S-D | SD | | P | ..P |
| Spiral | S | S | | ?,: | * |
| | | | | Color Classes | Code |
| Barred | B | B | | a | A |
| | (B) | SX | | af | AF |
| | B-S | BS | | f | F |
| | S-B | SB | | fg | FG |
| | | | | g | G |
| | | | | gk | GK |
| | | | | k | K |
| | | | | : | * |

(1) Low surface brightness

Table 6: Codes for Yerkes (Morgan) types

| Classes | Families | Stages | Type | Coding | Notes |
|---|---|---|---|---|---|
| Elliptical | | Ellipcicity (0-9) | E0 | E 0 | (1) |
| Sprial | Ordinary | | S | S | |
| | Barred | | SB | S B | |
| | Intermediate | | S (B) | S X | |
| | | a | Sa | S 0 | |
| | | b- | Sb- | S 2 | |
| | | b | Sb | S 3 | |
| | | b+ | Sb+ | S 4 | |
| | | c | Sc | S 5 | |
| | | - | S- | S 6 | |
| | | + | S+ | S 7 | |
| Irregular | | | Ir | I | |
| | | | Ir+ | I 9 | |
| Peculiar | | | P | P | |
| Peculiarities | | Bright nucleus | N | N | |
| | | Nebulous arms, mild case | (n) | N- | (2) |
| | | Nebulous arms, normal | n | N | |
| | | Nebulous arms, extreme | nn | N+ | |
| | | Patchy arms, mild case | (*) | K- | |
| | | Patchy arms, normal | * | K | |
| | | Patchy arms, extreme | ** | K+ | |
| | | Distorted arms,mild case | (t) | T- | |
| | | Distorted arms, normal | t | T | |
| | | Distorted arms, extreme | tt | T+ | |
| | | Peculiarity | p | P | |
| | | Uncertain ?,:,() | | * * * | (3) |
| Luminosity Classes | Code | Luminosity Classes | Code | | |
| I | 1 | III-IV | 6 | | |
| I-II | 2 | IV | 7 | | |
| II | 3 | IV-V | 8 | | |
| II-III | 4 | V | 9 | | |
| III | 5 | | | | |

(1) Includes lenticulars, especially in ES, E9
(2) Combined cases are coded NK, NT, etc
(3) Applies to symbol or group of symbols immediately preceding it

Table 7: Coding of DDO (van den Bergh) Types