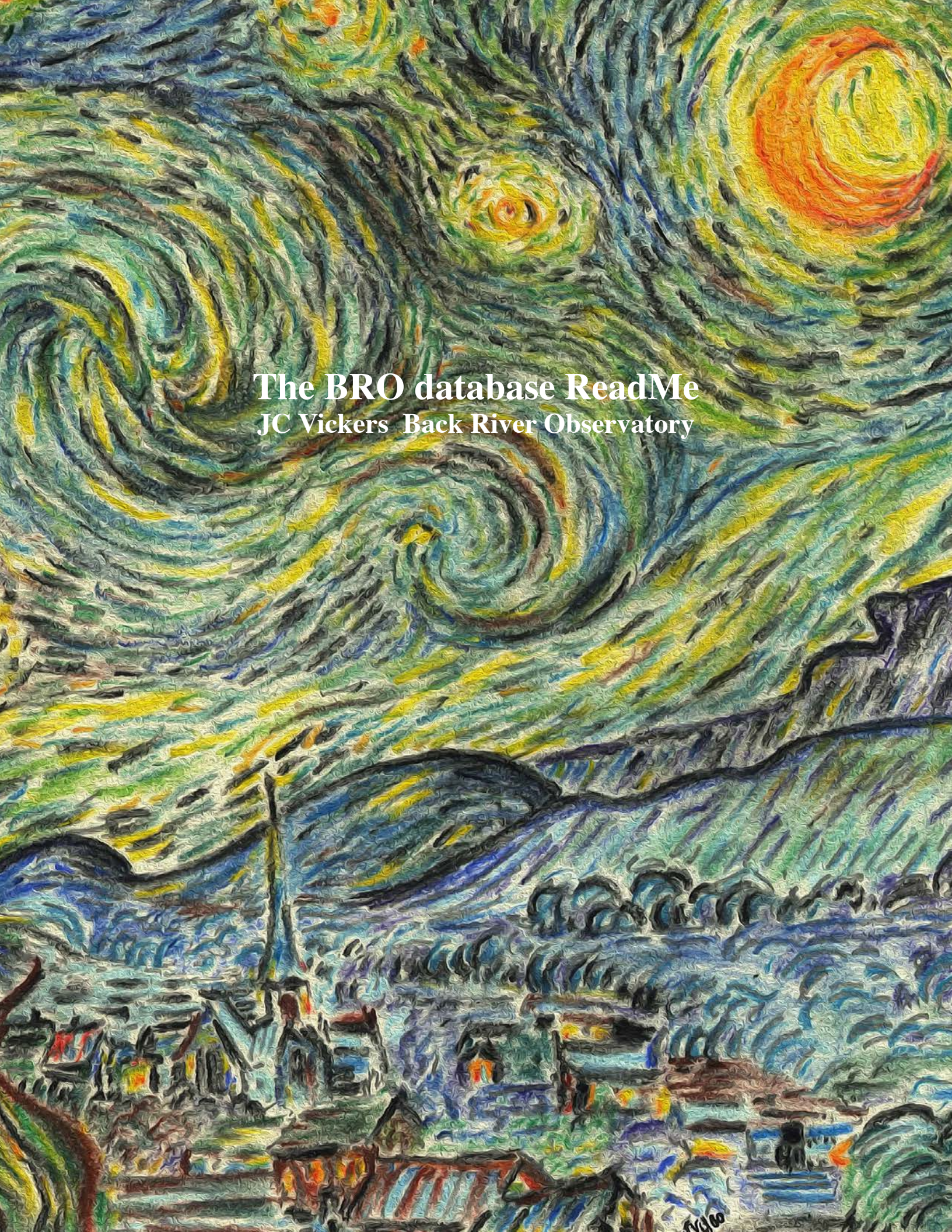

The BRO database ReadMe

JC Vickers Back River Observatory

The BRO database ReadMe

Understanding the image- and database.

QUICKSTART

Displaying both the information and the imagery is going to demand some screen space. The idea is to have the database file open to one side while you follow along with a desktop image folder open to display files as a lineup of icons.

Open and adjust the BRO database PDF: objects in a left-right list have the order of left is east-following, right is west-preceding (leading). This allows identification in many fields with no labeling. Image north is always up, and size is 15.1' arcminutes square if no size is mentioned (early images with a colored edge are 15.0'). In the PDF any bold object in line one is the primary target first described immediately below. BTW: your first PDF "Find" execution in Reader© takes a few seconds, thereafter it's quick; opt for "whole word searches" for better specificity.

When opening a Right Ascension folder at the desktop set folder view to "Film Strip" (PC) or "Cover Flow" (Mac). Set image thumbnail to the size you want; the list of folder images should now lie below a lineup of large thumbnails. Don't forget to widen the folder enough to see full names, which begin with the R.A. coordinate. You can now rapidly scroll or flow through the lineup of images. To see at full resolution double-click a selection. Many of the images are large, so you may have to scroll around to see full detail, which maxes out at about 150% enlargement. I suggest viewing in subdued ambient light with a fairly dark screen backdrop. Enjoy!

A LITTLE MORE DETAIL

A few introductory words, I'll add details about the images, clarify the data, list a few noteworthy information sources and give some well deserved credits.

Purpose of this project is threefold: assemble a comprehensive list of rewarding deep sky objects, incorporate sufficient reliable data to give substance to this select group, and present a relatively homogeneous source of revealing color images largely from POSSII plates. When available and necessary, a variety of image sources augment this mission; any individual astro-imager's work cited here should be treated as copyright protected, i.e., for personal, non-profit use only.

There are a few reasons for using non-POSSII images. Regions over 75' angular size can be arduous to compose. You can't get a good survey image for every single object. The dynamic range of the survey is limited: for instance, bright regions are blown out. Minute details can often be difficult to depict with this type of survey resolution. The infra-red plates suffered from significant quality and consistency issues. In a region from about 17h 00 to 19h 20 right ascension the availability of full blue exposures was limited. In order to avoid whiting out entire blue films with Milky Way stars, the surveyors cut some blue exposures way down for "Quick plates." Unfortunately, the blue plates most convenient to access (at STScI) south of about 0° declination are at a scanned resolution that requires about 168% artificial upsizing. So, these are some important limiting factors. Some pluses are that the color images are smoother, more interesting and realistic than grayscale, the entire sky is covered, and despite limitations the results meet the goals of quality and consistency.

How did I pick the target list. The gist of it is that it's an expansion of the *Deep Space CCD Atlases North and South*, by this author and A. Wassilieff. Selections generally have a certain minimum size, brightness, observable structure or at least interesting known characteristics that make them rewarding. Selectivity does vary: where sky density is low, I lower the standard. At any rate, reward is obviously more a function of cultivated taste and observing capacity than statistics.

How did I create the color images? It's IRB color: Infra-red to red channel, Red to green channel, Blue to blue channel. If you see red nebulosity, you know I got away with switching the infra-red and red plates; but I had better results from IRB and stuck with it. The color is not true, it's representative. A red item is deep red, blue is blue, green is really red. Minor color adjustment keeps the background realistic. The process produces more pleasing results in some intervals than others. Sometimes the green cast is pervasive, probably due to weaker than normal infra-red emulsion batches.
Much of the color process is scripted; but I manually align channels, which usually takes several minutes per object, working from a short table of recognizable, recurring combinations. Tracking error, plate-scan distortion and some noticeable star proper motion between long-delayed exposures complicates the process a bit.
The infra-red plate is a necessary but limiting factor to image quality. If you view one of these JPEG images in an image editor you'll see quite a difference between each color channel and final result. For galaxies, the color image often looks weak next to the blue channel, but this channel tends to blow out the core. See image 0516.5 ic405 or 2148.1 N7124 where I show blue contrasts.

As you know, images here bear little resemblance to what you see at the eyepiece. With good conditions, tuned apparatus, and a trained eye it's possible to conjure more subtlety than many deep images. Generally, however, optical views have the "lights turned down," and visual impressions are fleeting and subjective, for seeing is performed within our

ever-changing minds, through the windows of our eyes. For instance, we tend to see patterns in stars, and we are particularly effected by what we've recently seen: it's no accident that early NGC/IC discoverers found more challenging objects immediately *after* finding the first of a series, while missing brighter objects just preceding the first find.
That being the case, we can accurately collimate our minds, and raise essential energy and enthusiasm by learning the facts about what we observe, without necessarily expecting to see preconceptions.
I hope that the information and imagery here will increase receptivity, and improve observational sensitivity a notch.

Data categories, general line by line content —

Line one is an east-to-west array of major objects in the pertaining image. Object number in bold is primary member first described below. Next in line one is object class abbreviation or galaxy full Hubble morphological type (see ahead), constellation abbreviation (see ahead for list), shortened R.A. and declination. Galaxy blocks also include a brief Hubble type near the end. Major object classes are Galaxy Cluster (Ga Cl), Galaxy (Ga), Open Cluster (OC), Asterism (Ast), Globular Cluster (GC), Emission (Em) or Reflection (Refl) Nebula, Planetary Nebula (PN) and Dark Nebula (DkNeb).

Any notation in brackets [ ] emphasizes that the comment or opinion is the author's.

Line two may include brightness parameters of blue magnitude mb, visual magnitude mv, angular size, and Surface Brightness. PA is 0–180° Position Angle measure of galaxy main axis deflection CCW (east) from north (0°). Non-galaxies are typically given photo-visual brightness estimates. The word *estimate* is key here and throughout this project. I set out to present nothing but absolutely accurate, authoritatively reliable data. I sometimes settle for selecting an average of what appears to be the more dependable sources or perhaps the latest results. We have a great deal of information but it's arduous to vet. The day I realized that I cannot even trust *precisely* where north is for an image, I loosened up a bit. I find the most consistent of a reliable source group and use that.

In a group, there may be a note that a galaxy is a cD type, meaning large and diffuse central Dominant cluster galaxy. Next for galaxies is inclination or tilt estimate, reported with respect to line of sight: an edge-on object has 0° incline to the line of our view. Data comes from the MCG and UGC catalogs, from Notes at NED and other reliable sources; but values often conflict. I give more weight to UGC and NED Note values. On this same line may be a notation of "Field Galaxy" (belongs to no larger group, though another note may say it has a pair member), or "Isolated Galaxy" (has no gravitationally linked companion, but may still be inside a group).

Distances to objects: My intent is not to give a cosmology primer by explaining each parameter's meaning. I just want to give figures that are consistent and appropriate for the object type, and mention how I got the numbers. For galaxies I used mean red-shift independent distance in Megaparsecs by preference; if absent, the oft-similar galactocentric (Milky Way rotation-corrected) Hubble Flow distance may occasionally be used. For Galaxy Clusters co-moving radial distance in Megaparsecs is reported. This estimate factors out effects of space expansion over time, and generally better agrees with distance estimates of individual galaxies within the given cluster.

The Luminosity Class used is the NED homogenized value (vs. the DDO luminosity class system). Luminosity class is actually more about spiral arm development than illumination. The normal range is I to V (extendable to V-VI): Supergiants with long, distinct, bright arms to Dwarfs with only a hint of faint spirality. For more go to: http://ned.ipac.caltech.edu/level5/CLASSIFICATION/lucl.html. Also see end of galaxy discussion, ahead.

Actual size max of a galaxy is in Kiloparsecs. This NED figure is based on the maximum dimension at various wavelengths, which I interpret as the object including its faintest extremities. Depending on available information I occasionally call the figure the approximate actual (optical) size.

Now we're down to nearby star and object information, included as an indicator of seeing depth or as an identification aid. For consistency I try to use one software program for stellar visual magnitudes, but there can be big differences between sources for stars fainter than ~11m. For separations, I normally measure the viewed objects relying on proven position or scale indicators. This obviates some error due to imprecise database positions. That is, if you accurately overlay plotted object positions on an actual image you'll see that they often do not coincide.

At this point, object fundamentals are complete. If no other object includes a fundamental description, we proceed to Designation, below. If we continue with other basic descriptions, then when completed you will see a blue alert line that we are returning to original primary object in greater depth.

Designation lists popular cross-references or aliases of object in bold on the first data line. Most of the catalog aliases are from NED, DOCdb, and a few from NGCICProject websites (see credits at end for addresses). Note that designated catalogs often hint at properties if you know the catalog expanded name. There are catalogs for every object type and sub-type, for galaxies alone: infra-red, UV, radio or X-ray sources; cluster, multiple, double, flat, edge-on, compact or

peculiar systems, and so on. In some cases, first or early usage of a galaxy catalog abbreviation is explained there with the data, in parentheses. Online, the NED website or Wikipedia describes the catalogs.

Dreyer: Year 1888-plus, NGC/IC comments. Occasionally these comments pertain to ID's lately deemed incorrect.

RA-Dec: Epoch 2000 Coordinates. Right Ascension hr./min./sec. Declination degree/min./sec.
"Precise" positions reported have some *latitude*, especially for diffuse objects. Some objects have an official geometric position that differs from the apparent or geographic "center of gravity." Some objects have obviously wrong official coordinates which, by the way, can only be corrected by publication in an approved professional journal.

Other: Descriptions derive from RC1 Notes (beginning ~1964), as well as from Arp Atlas, RNGC, Burhnam's Handbooks, S. Gottlieb, H. Corwin, this author, and so on. Impressions in the Notes don't conflict so much as they evolve over time.

An "(rs)" inner ring is a transition between a normal inner ring (r) and an incipient S-spiral-arm pattern (s). Light speed "C" ≈ 299,792 km/s. Near-equally reliable data for the same parameter, like size or distance, may both be reported. Note that "?" can mean possible or very uncertain. Parsec (pc) = 3.262 light years (l.y. or lt.yr.). Recall that objects and stars in any field may have vastly different depth-distance positions. Something being "on" or "near" another thing is often just a linear (2-D) alignment. Object ages are typically approximate. Distances (from Sun) and size figures are linked and more vulnerable to revision the less they've been studied. More catalog designations and Notes indicate more studies. During a verification run I noticed many NED distance and actual-size figure updates after only a few months! RV is radial velocity (from red shift) of object approach (-) or recession (+). See Galaxies, ahead for an explanation of RC3 Types.

MAIN OBJECT CLASSES EXPANDED

Open Cluster data for "(Diaz)" comes from a catalog of 1599 clusters or fragments/remnants, and star groups: New catalog of optically visible open clusters and candidates. Diaz W.S.+ <Astron. Astrophys. 389, 871 (2002).>

Trumpler (Tr) OC class: I-IV of decreasing detachment and weakening core concentration. Class I is well detached with strong core compression, class IV still has a density above surroundings, but no detachment and no core at all. Arabic numbers 1-3 tell of increasing brightness range: 1 has similar stars, 3 has a wide member brightness range. Trumpler richness class has "p" for star poor at ≤50 members, "m" for moderately rich at 50-100, and "r" is rich at ≥100. Lastly, "n" means nebulosity is present. Very rich and very poor descriptors seems to have been dropped.

As available, original Trumpler class and its 1982 re-examination set are both reported. Derivation: CDS VII/92 Lund catalogue of Open Cluster Data, Fifth edition, G. Lynga, 1987, with online updates and more recent Alter Bibliography notes. Also consulted: CDS VII/101A Star Clusters/Associations. III, and Open Clusters (Ruprecht+ 1983).

Open cluster sizes usually chosen here are the ostensibly more reliable "selected" angular size of Lynga. The value may exclude any supposed stellar corona or halo not obviously differentiated from surrounding sky.

Globular cluster concentration toward center encodes counter-intuitively: very high = 1, very low = 12. GCL = number in Catalogue of Star Clusters & Associations II. Globular Clusters (Ruprecht+ 1981); CDS files #VII/103, VII/44B. Also see Catalog of Parameters for Milky Way Globular Clusters, Harris, W.E. 1996, AJ, 112, 1487; and, Structure Parameters of Galactic Globular Clusters, Webbink, R.F., in <IAU Symp 113 "Dynamics of Star Clusters", Ed. J. Goedman and P. Hut, 541 (1985)> CDS file #VII/151.

Globular cluster composite or integrated spectral types indicate temperature, color, and constitution trends. Earlier-hotter-bluer common types (O, B, A) tend toward less heavy-element makeup of cluster stars than later-cooler-redder types (G, K, M, N, etc.); w/ F (white) stars intermediate.

G.C. Shape: Circular = 0% for (1 - axis b/axis a), very circular = 1–6% out of round, pretty circular = 7–13%, pretty elliptical = 14–20%, very elliptical = 21–27(max.)%. Also, Max/Core diameter ratio describes central concentration.

Globular Central Luminosity Density is log of Solar luminosities per cubic parsec: low = 0.1–1.95, moderate = 1.96–3.8, high = 3.9–5.7+(max.). Harris data is at: http://www.physics.mcmaster.ca/resources/globular.html .

Many G.C. luminosities were calculated as follows: log (L_G.C./L_Sun) = 0.4 (4.83 - M_Vt), where L is Luminosity, and M_Vt is absolute magnitude. Cluster mass may be approximated by doubling this luminosity (in Solar units), according to the "mass to light ratio". (Private communication w/ W. Harris, 1/04.)

Diffuse nebulae are like open clusters and galaxy clusters in that they can be hard to pin down. For nebulae there is often little brightness data, perhaps some photo-red and verbal estimates; size and position may also be estimates. Often the assumed illumination source distance is curiously far from that of the nebula. Additional sources of details follow. Catalog of Reflection Nebulae, van den Bergh, 1966; U.S. National Space Sciences Data Center (NSSDC) and Astronomical Data Center (ADC) catalog #7021. Catalog of Bright Diffuse Galactic Nebulae, Cederblad S., 1946,

<Lund Medd. Astron. Obs. Ser. II, 119, 1 (1946)>, CDS file VII/231. Catalogue of HII Regions, Sharpless S., <Astrophys. J. Suppl. Ser. 4, 257 (1959)>, CDS VII/20.

Planetary nebula expansion velocity derives from various ion (OIII, NII…) studies. RV is heliocentric radial velocity; ± precedes mean error. PNG = Planetary Nebula Galactic long.-lat. # in the SEC: Strasbourg-ESO Catalogue of Galactic Planetary Nebulae, Acker+, 1992. PNG "discoverer," often attributes to the who and when of entry into their catalog.

Galaxies: RV = kilometers/second mean radial velocity of recession (+) or approach (-). Any RV here with ± error is corrected for the Sun as the center of observation (optical heliocentric) but unadjusted for Galactic rotation. For galaxies, Galactocentric RV is preferred and a bit more widely available of the two. Local-Group or even Virgo-Group corrected RV should even more accurately depict a given galaxy motion. As we try to eliminate all extraneous motion between observer and objective we distort how the object moves from where we actual are, as opposed to a center of all shifting things. RV data is included as galaxies moving faster away are often farther away (as per Hubble's Law); and similar values evince group membership. Making these links with accuracy brings us back to the canceling of extraneous motions. Anyway, for our purposes Heliocentric values are little different (-5 to +11% typical observed discrepancies) than versions corrected for Galactic rotation.

For **RC3 Type** (mean revised morphological type of the RC2 system) see Third Reference Catalog of Bright Galaxies (RC3), de Vaucouleurs+. I include this data to unify Type "migrations" in the literature. RC3 Types have elaborate vocabulary (often not fully exploited), and it is the most widely applied and available morphology classifier.
RC3 Type is a 7-slot code; a dot indicates a blank at given data position. Expanded Hubble types may not agree.

Dot/slot-1 is peculiarity: c=compact galaxy (intensely bright and star-like), d=dwarf Ga, P=Pseudo/false Outer Ring, R=Outer Ring, L=Outer Lens.

Dot/slot-2 is Class: E=elliptical, L (S0)=lenticular (lens-like), S=Spiral (arms), I=Irregular (chaotic), P=Peculiars.

Dot/slot-3 is Family: ordinary=A, barred=B, X=intermediate types, e.g.: SX = SAB or S(B), ordinary-barred transition. Im, I0 are Irregulars of Magellanic=m (resolvable into stars) or Non-Magellanic=0 (amorphous) type.

Dot/slot-4 is Varieties and Elliptical Stages. Varieties: R=r or inner ring, R'=r' or pseudo inner ring, S=s-shaped, T=sr or mixed arm pattern, L=(rl) or lenticular inner lens ring. Elliptical (E) ellipticity stages are 0–7.

Dot/slot-5 is Stage: Lenticular or Spiral ellipticity. Lenticulars are .L..- (early), .L..0 (intermediate.), .L..+ (late). Spirals are 0 to 9. By the familiar Hubble stage: 0=S0/a, 1=Sa, 2=Sab (=Sb-), 3=Sb, 4=Sbc (=Sb+), 5=Sc, 6=Scd, 7=Sd, 8=Sdm, 9=Sm. Example: SXT5* = SABc, transitional barred spiral of mixed rs arms with c subtype being uncertain.

Dot/slot-6–7 is Stage of feature-qualifier (RC3 types lack codes for nebulous, patchy, or distorted arms, as in DDO types). Qualifiers pertain to preceding feature: P=Peculiarity, ...* = ":" or uncertain, ...$ = "?" or doubtful, .../ = sp or spindle (tapered long axis). See data for A444, N7806 or N7 for some brief type explanations.

After the 7-slot RC3 Type is the extension for "T" index along the popular Hubble stage-of-development sequence: -6=cE, -5=E0-1, -4=E+, -3=S0-, -2=S0°, -1=S0+, 0=S0/a, 1=Sa, 2=Sab, 3=Sb, 4=Sbc, 5=Sc, 6=Scd, 7=Sd, 8=Sdm, 9=Sm, 10=Im, 11=cI, 90=I0, 99=Pec. Circumflex denotes superscript: S0^- = S0⁻, S0^0^ = S0°.
Next figure is mean error on previous Hubble stage number, as a range indicator ("±" understood).
Last, for spiral and irregular galaxies (as available in the RC3), is Luminosity class for arm-pattern strength. Supergiant ("S.Giant") is brightest in a normal range of 1.0 to ~2, also designated I or I-II. Dwarf is least luminous at 9.0 ±1 approximate range, being IV-V or V (extendable to VI). In between are: Bright Giant at 3.0 ±1, covering I-II, II or II-III; Giant at 5.0 ±1, for II-III, III or III-IV; and Subgiant at 7.0 ±1, for III-IV, IV or IV-V.
Luminosity error (±) completes this information block, as space and availability allow.

For other galaxy data used in this study: ftp://cdsarc.u-strasbg.fr/pub/cats/VII/170, Catalogue of Southern Peculiar Galaxies and Associations, Volume I. Positions and descriptions, Arp H.C., Madore B.F., <Cambridge University Press (1987)>. Also: VII/116 Southern Galaxy Catalogue (SGC), Corwin, H.G., de Vaucouleurs, A., de Vaucouleurs, G., <The University of Texas Monographs in Astronomy No.4.

Galaxy Clusters, but for a few, they are challenging to observe directly. Denser groups are impossibly remote, leaving the faintest of impressions to even our deepest sensors — objects lost in the abyss, fleeing at appreciable fractions of light speed. It seems that less than some 75 clusters offer enough bright, near components to savor, even photographically. It's not surprising that agreement between current information sources is scant; so, consider data to be tentative.

Abell relentlessly applied the qualifier "apparent" to his clusters and their members. He excluded clusters from his study which did not meet qualifications, holding on to them as a finder list.

Coordinates for many open clusters and diffuse nebulae, and all galaxy clusters originate from rough positions. Not amenable to precise location, galaxy cluster positions typically round off to declination min.s and to R.A. min. tenths.

"Data Observation Window" size is based on arcane computations involving distance and red shift. Suffice to say, windows draw a minimal circle within which to count a statistically adequate sample. Cluster diameter estimates may be larger or smaller than these windows. Cluster area derives from one of the cited diameter opinions via $A=\pi r^2$. Note that, within these areas, more galaxies may have been excluded as back- or foreground than "counted" as members.

Bautz-Morgan classes: I = cluster contains a centrally located cD galaxy; II = brightest galaxy or galaxies are intermediate in appearance between class cD and normal Virgo-type giant ellipticals; III = cluster contains no clearly dominant galaxies. Type cD signifies an enormous superluminous galaxy: c signifying a centrally located object of supergiant brightness, D denoting Dominant or late-stage elliptical type with a large diffuse halo. Class cD is intended for the brightest one or two galaxies in a cluster, objects normally being elliptical with a faint, extensive corona.

Abell Cluster classes: Regular = even member distribution; Irregular dispersal may be randomly smooth or clumpy.

Galaxy cluster source material is abundant. Much of it stems from George Abell's 1957 PhD thesis at C.I.T., updated in CDS VII/110A, A Catalogue of Rich Clusters of Galaxies, Abell G.O., Corwin Jr. H.G., Olowin R.P., <Astrophys. J. Suppl. Ser. 70, 1 (1989)>. Other examples: CDS VII/96, A Catalog of Morphological Properties of the 2712 Abell Clusters, Struble M.F., Rood H.J., <Astrophys. J. Suppl. Ser., 63, 555 (1987)>. Also: CDS VII/87A, Data on 1889 of Abell's Rich Clusters of Galaxies, Leir A.A., van den Bergh S., <Astrophys. J. Suppl. Ser. 34, 381 (1977)>. Also: CDS VII/4A, Catalogue of Abell and Zwicky Clusters of Galaxies, Abell G.O., <Astrophys. J. Suppl. Ser. 3, 211 (1958)> and Corwin H.G., <Astron. J. 79, 1356 (1974)>.

Concerning the database in general, I made compromises to maintain a single, manageable file. There may be too much of some information, too little of other; it's dense, a bit cryptic and technical; and there will always be deficiencies eluding me within it. I'll keep at it; meanwhile, I welcome comments about how to improve the project.

A lesson from this study is that we are still just climbing out of a state of ignorance as to deep space. Astronomical measurements can represent mankind's highest level of accuracy, yet some parameters vary wildly. The Hubble constant: with it we compute space expansion, galaxy absolute magnitude and distance. Over decades I've seen the value zero in from a range of 50 to 100 to a present figure of about 68 km/s/Mpc. Such accuracy improvement combines with a rapid rise of new available information. So, though this database may be complete to a degree, it's never quite up to date.

CONSTELLATIONS

And..... Andromeda
Ant..... Antlia
Aql..... Aquila
Aqr..... Aquarius
Ari..... Aries
Aur..... Auriga
Boo..... Boötes
Cam..... Camelopardalis
Cap..... Capricornus
Cas..... Cassiopeia
Cen..... Centaurus
Cep..... Cepheus
Cet..... Cetus
CMa..... Canis Major
CMi..... Canis Minor
Cnc..... Cancer
Col..... Columba
Com... Coma Berenices
CrA... Corona Australis
CrB.... Corona Borealis
Crt..... Crater
Crv..... Corvus
CVn..... Canes Venatici
Cyg..... Cygnus
Del..... Delphinus
Dra..... Draco
Equ..... Equuleus
Eri..... Eridanus
For..... Fornax
Gem..... Gemini
Gru..... Grus
Her..... Hercules
Hya..... Hydra
Lac..... Lacerta
Leo..... Leo
Lep..... Lepus
Lib..... Libra
LMi..... Leo Minor
Lup..... Lupus
Lyn..... Lynx
Lyr..... Lyra
Mon..... Monoceros
Oph..... Ophiuchus
Ori..... Orion
Peg..... Pegasus
Per..... Perseus
PsA..... Piscis Austrinus
Psc..... Pisces
Pup..... Puppis
Pyx..... Pyxis
Sco..... Scorpius
Scl..... Sculptor
Sct..... Scutum
SerCd..... Serpens Cauda
SerCp..... Serpens Caput
Sex..... Sextans
Sge..... Sagitta
Sgr..... Sagittarius
Tau..... Taurus
TrA...Triangulum Australe
Tri..... Triangulum
UMa..... Ursa Major
UMi..... Ursa Minor
Vir..... Virgo
Vul..... Vulpecula

SOME CATALOG EXPANSIONS (largely, courtesy of W. Steinicke)

A..... Anonymous galaxy from RC2 (de Vaucouleurs' Reference Catalogue of Bright Galaxies, v.2).

Abell..... Planetary nebula. George Abell cataloged faint Planetary Nebulae from a visual inspection of POSS I (Palomar Observatory Sky Survey, first survey) plates. Abell planetaries also have PK designations.

AB ..... Abell — He also cataloged faint clusters of galaxies from the POSS I plates, which bear at least two other equivalent acronyms: AGC (Abell Galaxy Cluster) or RCG (Catalogue of Rich Clusters of Galaxies).

AM ..... Arp & Madore (southern peculiar galaxy).

Andromeda.... Constellation Andromeda. Some objects are designated by discovery order in a given constellation, or simply by the constellation in which they are found: Andromeda I, Andromeda II, etc., or the Aquarius Dwarf, the Sagittarius Dwarf, and so on.

ARAK ..... Arakelian (galaxy).

ARP..... Atlas of Peculiar Galaxies, Halton C. Arp, AJ supplement 123, vol. XIV, pp. 1-20, 11/66.

B ..... E. E. Barnard. 349 objects from the 1927 'A Photographic Atlas of Selected Regions of the Milky Way', the first photographic survey of the northern milky way to illustrate 'starless voids', which we now know to be opaque clouds of gas or dust that obscur the background star field.

Basel..... Basel Astronomical Institute. New Open Clusters. Latest is number 20.

BCL..... Boulesteix cluster (HII region in M33).

Berkeley ..... Open cluster. University of California at Berkeley investigations of POSS I plates for faint (often extremely faint) and rich open star clusters. 90 known. As with many of the cluster surveys within the Lynga (Lund) master list, positions are not infrequently imprecise, and known cross-referencing (rough equivalents in other cluster catalogs) is sporadic.

Bochum ..... Open cluster. Example: NGC 2409 = Bochum 4.

3C..... Third Cambridge Catalogue of Radio Sources.

CAG, CGS .... Carnegie Atlas of Galaxies, vol. 1 and 2. Also, CGS: http://cgs.obs.carnegiescience.edu/CGS/Home.html

CAN ..... Galaxy Cluster Assignment Number.

CED..... Cederblad, 1946 (diffuse galactic nebula). Stefan Cederblad. 'Studies of bright diffuse galactic nebulae with special regard to their spatial distribution'.

CGMW..... Catalogue of Galaxies Behind the Milky Way.

COU ..... Coutès (H-alpha emission nebula).

Cz, Czk..... M. Czernik. 'New Open Clusters' listing.

DCL..... Dickens, Currie, Lucey (galaxy in Centaurus Custer).

DDO ..... David Dunlop Observatory (dwarf galaxy).

DFOT ..... Doi, Fugugita, Okamura, Tarusawa (galaxy in Coma Cluster).

DG..... Dorschner & Gürtler (reflection nebula).

Djargovsky .... Globular cluster: for instance, NGC 6540 = Djargovsky 3.

Do..... Dolidze open cluster. Generally bright but scattered, poor, not well detached star groups.

DoDz ..... Dolidze/Dzimselejsvili. A list of 34 neglected entries from star cluster catalogues located at relatively high galactic latitudes which appear to be candidate late stages of star cluster dynamical evolution, from a paper entitled 'Dissolving star cluster candidates', which describes what to expect by way of appearance.

DRCG ..... Dressler Cluster of Galaxies (galaxies in different clusters).

DWB ..... Dickel, Wendker, Bieritz. A catalog of Ha (Hydrogen Alpha) emission nebulae in the Cygnus X region. Most of these are faint to very faint photographic nebulae.

ESO ..... ESO/Uppsala Survey of the ESO(B)-Atlas. From the European Southern Observatory southern hemisphere photographic survey from Chile. Format: first number = field, second number = object in field. If the format contains no letters, the object is a galaxy, otherwise letters are used for special types: RN=reflection nebula (e.g. ESO 123-RN7), SC=star cluster, EN=emission nebula, PN=planetary nebula, *N=star(s) in nebula, N*=nebula and star.

FAIR..... Fairall (compact and bright nucleus galaxy).

Fath ..... Galaxy: Fath 703 = NGC 5892.

FCC ..... Fornax Cluster Catalogue.

FGC..... Flat Galaxy Catalogue (the extension is FGCE; the addendum is referred by a following 'A').

GCL..... Globular Cluster; from the Catalogue of Star Clusters and Associations.

GN..... Atlas of Galactic Nebulae. Compilation of Milky-Way nebulous objects from the POSS I survey for north of -33 degrees declination, and from the ESO/SRC Atlas for south of -33 degrees declination.

HARO ..... Galaxy with UV excess.

Henize ..... Planetary nebula; NGC 5408 = Henize 959.

HCG ..... Hickson compact group of galaxies. (Hick and H also used as prefixes).

Holm ..... Holmberg Dwarf galaxy; Holmberg VI (Holmberg 004) = NGC 1325A.

IAU ..... International Astronomical Union.

IC..... Index Catalog. Additional objects to supplementing the NGC. Published in two installments. Objects originate from a variety of observers' notes, and via photographic inspection. The assemblage is fraught with duplications and debatable positions. Follow the NGC/IC Project link for background information.

IRAS ..... IRAS catalogue of infrared sources.

J ..... Jonkheere; J 475 = NGC 6741 (planetary nebula).

KARA ..... Karachentseva (isolated galaxy).

KAZ ..... Kazayan (emission line galaxy).

KCPG..... Karachentsev isolated pair of galaxies.

KDWG ..... Karachentsev dwarf galaxy.

Keeler..... Galaxy; NGC 5866A = Keeler 690.

King..... I. King. A Harvard astronomers 'New Open (galactic) Clusters' listing. Latest number is 26.

KUG..... Kiso UV galaxy.

LBN..... Lynds' (Beverly,) Bright Nebula (emission nebula) Catalog. 1965 photographic catalog of HII regions from the POSS I red plates.

LDN ..... Lynds' (Beverly,) Dark Nebula Catalog; LDN 1653 = NGC 2313. 1962 photographic catalog of dark nebulae from the POSS I red plates.

LGG ..... Lyon Group of Galaxies catalogue.

LT ..... L. Thompson (ring galaxy).

Lund ..... Open cluster. "Catalogue of Open Cluster Data, 5th Edition" is based on documentation received by Gösta Lyngå in February 1987. Catalog includes 1212 eclectic "entries" that cross-reference with OCL cluster.

M ..... C. Messier; M 110 = NGC 205 is included, M 40 and M 45 are not; all others, except M 25 = IC 4725, are in the NGC. Charles Messier was a French amateur comet hunter of the mid 1700's. He began listing nebulous comet-like objects which did not change their nightly sky position — being non-comets. This visually compiled listing from several comet hunters contains many of the biggest, brightest deep-sky examples visible from the Northern hemisphere.

MCG ..... Morphological Catalogue of Galaxies; first number = declination zone (+15 to -6, "+" sign is omitted), second number = field in zone (by right ascension), third number = galaxy in field. Morphological Catalog of Galaxies. Comprehensive Soviet classification of galaxies based on the POSS I plates.

Mel ..... Melotte (open cluster); Mel 15 = IC 1805.

MK ..... Markarian (galaxy with UV continuum).

MOL..... A Master List of Nonstellar Optical Astronomical Objects. This is a 1980 book that is a compendium of approximately 185,000 listings from 270 catalogs. [Not the most user-friendly resource.]

MRSL..... Mars'alkov'a Catalogue of galactic nebulae, 1974.

OCL..... Open Cluster; from the Catalogue of Star Clusters and Associations.

New ..... Galaxy (Shapley-Ames); New 2 = NGC 4507. Also observe frequent ESO equivalents.

NGC ..... "New General Catalogue of Nebulae and Clusters of Stars", Dreyer's great visual catalog of 1886, from the 1864 "General Catalogue" — complied largely by Sir William and Sir John Herschel from observations in the mid 1800's from both hemispheres. As recent as 1973 the NGC was rather problematically "revised" into the RNGC. As with the IC catalog, see The NGC/IC Project for more details. Also, search out The Interactive NGC Catalog Online from SEDS.

NPM1G..... Lick Northern Proper Motion Survey Galaxy Catalogue; Format: declination zone (°) + number.

Pal ..... Palomar Globular Clusters. Very faint Globular Clusters discovered on POSS I plates.

Parsamyan..... E. S. Parsamyan. From an Armenian astronomer's 1965 catalog.

PGC..... Catalog of Principal Galaxies.

PHL ..... Palomar-Haro-Luyten (blue star or galaxy); PHL 1226 = IC 1746.

PK ..... L. Perek and L. Kohoutek (planetary nebula); format: galactic coordinates. The 1967 'Catalogue of Galactic and Planetary Nebulae'. The first extensive catalog of the various later stages of stellar evolution (when stars expel their outer layers).

PNG..... Planetary Nebulae, Galactic coordinates. Designation is from the 'Strasbourg-ESO Catalogue of Galactic Planetary Nebulae' — one of the most comprehensive catalogs of planetary nebulae, published by the European Southern Observatory.

PRC ..... Polar ring galaxy.

RB ..... Rood & Baum (galaxy in Coma Cluster).

RB ..... Raab open cluster.

RBS ..... ROSAT Bright Survey.

Reinmuth..... Galaxy; Reinmuth 80 = NGC 4517A.

Reiz ..... Galaxy (this identification is given only if no other identification is available).

Ruprecht..... Open cluster (Ruprecht 166 = NGC 5120).

SBS ..... Second Byurakan (Biurakan) Survey (UV excess objects).

SCL- NED..... Super CLuster, NASA Extragalactic Database (NED).

SDSS ..... Sloan Deep Sky Survey.

SG ..... Shain & Gaze (emission nebula).

SGC..... Southern Galaxy Catalogue.

Sh2 ..... Sharpless (emission nebula). From the second catalog of HII regions by S. Sharpless. Found from examination of the red POSS I plates

Shkh ..... Shakhbazian (compact galaxy in compact group).

SS ..... Struve & Straka (galactic nebula); SS 20 = IC 2067.

1SZ, 2SZ..... Southern Zwicky compact galaxies (2 lists).

Todd ..... Todd (galaxy); found during his Telescopic Search for the Trans-Neptunian Planet", AN 113, 153 (1885); some new identifications were found by Klaus Wenzel.

TOL..... Tololo (emission line galaxy).

UGC ..... Uppsala General Catalogue of Galaxies. Based on POSS I plates. Complete to a diameter of 1.0 arc minute, north of -02 degrees 30 minutes of declination.

UGCA ..... Catalogue of Selected Non-UGC Galaxies.

UM ..... University of Michigan (emission line galaxy).

URA ..... Uranova (stellar ring); URA 50 = IC 1311.

VCC ..... Virgo Cluster Catalog (galaxy).

vdB(-Hagen) . Van den Bergh-Hagen (open cluster); VdB-Hagen 208 = NGC 6256.

VDB (vdB).... Van den Bergh (reflection nebula); VDB 66 = NGC 2149. Sidney van de Bergh, from the 1966 paper on 'A study of Reflection Nebulae'. Found from examining the blue POSS I plates.

VMT..... Van den Bergh, Marschner & Terzian (supernova remnant); VMT 9 = IC 443.

VV..... Vorontsov-Velyaminov (interacting galaxy).

WAS ..... Wasilewski (emission line galaxy).

Z..... Galaxy listed in the Catalogue of Selected Compact Galaxies and of Post-Eruptive Galaxies only by 1950-coordinates, which are appended.

ZH ..... Zwicky-Humason (galaxy in Abell 194); IC 1693 = ZH 32.

SOURCES ON THE MAIN OBJECT CLASSES

Open Clusters:

• New Catalog of Optically Visible Open Clusters and Candidates, Diaz W.S., et al. Astron. Astrophys. 389, 871, 2002; or, ftp://cdsarc.u-strasbg.fr/cats/VII/229.

• Lund Catalogue of Open Cluster Data, Fifth edition, G. Lynga, 1987; or, CDS #VII/92.

• Star Clusters/Associations. III Open Clusters, Ruprecht et al., 1983; or, CDS #VII/101A.

Globular Clusters:

• Catalogue of Star Clusters & Associations II. Globular Clusters, Ruprecht et al., 1981.

• CDS files #VII/103, #VII/44B.

• Catalog of Parameters for Milky Way Globular Clusters, Harris, W.E. 1996, AJ, 112, 1487; or, http://www.physics.mcmaster.ca/resources/globular.html

• Structure Parameters of Galactic Globular Clusters, Webbink, R.F., (from IAU Symp. 113: "Dynamics of Star Clusters", Ed. J. Goedman & P. Hut, 541, 1985); or, CDS file #VII/151.

Planetary Nebulae:

Strasbourg-ESO Catalogue of Galactic Planetary Nebulae, Acker et al., 1992.

• Catalogue of Galactic Planetary Nebulae, Perek, L., and L. Kohoutek, Academia Publishing House of the Czechoslovak Academy of Sciences, Prague, 1967.

Diffuse Nebulae:

• Catalog of Reflection Nebulae, van den Bergh, 1966. At ADC as catalog #7021.

• Catalog of Bright Diffuse Galactic Nebulae, Cederblad S., 1946, Lund Medd. Astron. Obs. Ser. II, 119, 1, 1946; or, CDS file #VII/231.

• Catalogue of HII Regions, Sharpless S., Astrophys. J. Suppl. Ser. 4, 257, 1959; or, CDS #VII/20.

Galaxies:

• Catalogue of Southern Peculiar Galaxies and Associations, Vol. I. Positions and Descriptions, Arp H.C., Madore B.F., Cambridge University Press, 1987; or, ftp://cdsarc.u-strasbg.fr/pub/cats/VII/170.

• Third Reference Catalogue of Bright Galaxies, de Vaucouleurs, G., A. and H. et al., Springer-Verlag, New York. 1991; or, CDS #VII/155.

• Paturel, G., et al. Catalogue of Principal Galaxies. LEDA. 2000.

• Southern Galaxy Catalogue (SGC), Corwin, H.G., de Vaucouleurs, A., de Vaucouleurs, G., The University of Texas Monographs in Astronomy No.4; or, CDS #VII/116.

• Atlas of Peculiar Galaxies, Arp, H., The Astrophysical Journal, Supplement No. 123, Vol. 14, pp. 1–20. November, 1966.

• Atlas and Catalogue of Interacting Galaxies, Part I, Vorontsov-Velyaminov, B. A., Moscow. 1959. (Part II, see: Astron. Astrophys. Suppl. 28, 1. 1977.)

• Morphological Catalogue of Galaxies, Vol. I-IV, Vorontsov-Velyaminov, B. A., et al., Moscow. 1962-1968.

• Catalogue of Galaxies and of Clusters of Galaxies (CGCG), Vol. 1-6, Zwicky, F., et al., Pasadena. 1963-68.

• Catalogue of Selected Compact Galaxies and of Post-Eruptive Galaxies, Zwicky, F., et al., Zurich, 1971.

• Eighth List of Compact Galaxies", Zwicky, F., et al., Astron. J. 80, 545. 1975.

Galaxy Clusters:

• A Catalogue of Rich Clusters of Galaxies, Abell G.O., et al., Astrophys. J. Suppl. Ser. 70, 1, 1989; or, CDS #VII/110A.

• A Catalog of Morphological Properties of the 2712 Abell Clusters, Struble M.F., et al., Astrophys. J. Suppl. Ser., 63, 555, 1987; or, CDS #VII/96.

• Data on 1889 Abell's Rich Clusters of Galaxies, Leir A.A., et al., Astrophys. J. Suppl. Ser. 34, 381, 1977; or, CDS #VII/87A.

• Catalogue of Abell and Zwicky Clusters of Galaxies, Abell G.O., Astrophys. J. Suppl. Ser. 3, 211, 1958 (and, Corwin H.G., Astron. J. 79, 1356, 1974); or, CDS #VII/4A.

• Edinburgh-Durham Southern Galaxy Catalogue IV. The cluster catalog, Lumsden S.L., et al., Mon. Not. R. Astron. Soc. 258, 1, 1992; or, CDS #VII/175.

CREDIT WHERE IT'S DUE

The Digitized Palomar Observatory Sky Survey producers (See below. http://www.astro.caltech.edu/~george/dposs/).
The STScI Digitized Sky Survey (http://archive.stsci.edu).
NASA/IPAC EXTRAGALACTIC DATABASE NED — (http://ned.ipac.caltech.edu/forms/byname.html).
Bob Erdmann and company of The NGCICProject (http://www.ngcic.org/).
Amateur astronomer extraordinaire, Steven Gottlieb (www.astronomy-mall.com/Adventures.In.Deep.Space/index.html).
Master solver of astronomical riddles, Dr. Harold G. Corwin, Jr. (http://www.ngcicproject.org/corwin/default.htm).
The developers of the phenomenally useful www.WikiSky.org website.
The Sloan Digitized Sky Survey (See below. http://www.sdss.org).
Centre de Données Strasbourg CDS (http://cdsweb.u-strasbg.fr http://vizier.u-strasbg.fr).
DOCdb online database (http://www.docdb.net/object_index.php).
The NightSkyAtlas of NGC and IC objects (http://www.nightskyatlas.com /ngcData /icData).

Palomar Observatory Sky Surveys I and II (POSSI, POSSII)

The Digitized Sky Surveys were produced at the Space Telescope Science Institute under U.S. Government grant NAG W-2166. The images of these surveys are based on photographic data obtained using the Oschin Schmidt Telescope on Palomar Mountain and the UK Schmidt Telescope. The plates were processed into the present compressed digital form

with the permission of these institutions.

The Second Palomar Observatory Sky Survey (POSS-II) was made by the California Institute of Technology with funds from the National Science Foundation, the National Geographic Society, the Sloan Foundation, the Samuel Oschin Foundation, and the Eastman Kodak Corporation.

The Oschin Schmidt Telescope is operated by the California Institute of Technology and Palomar Observatory.
The UK Schmidt Telescope was operated by the Royal Observatory Edinburgh, with funding from the UK Science and Engineering Research Council (later the UK Particle Physics and Astronomy Research Council), until 1988 June, and thereafter by the Anglo-Australian Observatory. The blue plates of the southern Sky Atlas and its Equatorial Extension (together known as the SERC-J), as well as the Equatorial Red (ER), and the Second Epoch [red] Survey (SES) were all taken with the UK Schmidt.

Supplemental funding for sky-survey work at the ST ScI is provided by the European Southern Observatory.
The "Second Epoch Survey" of the southern sky was made by the Anglo-Australian Observatory (AAO) with the UK Schmidt Telescope. Plates from this survey have been digitized and compressed by the ST ScI. The digitized images are copyright © 1993-5 by the Anglo-Australian Observatory Board, and are distributed herein by agreement.

The "Equatorial Red Atlas" of the southern sky was made with the UK Schmidt Telescope. Plates from this survey have been digitized and compressed by the ST ScI. The digitized images are copyright © 1992-5, jointly by the UK SERC/PPARC (Particle Physics and Astronomy Research Council, formerly Science and Engineering Research Council) and the Anglo-Australian Telescope Board, and are distributed herein by agreement.

The compressed files of the "Palomar Observatory — Space Telescope Science Institute Digital Sky Survey" of the northern sky, based on scans of the Second Palomar Sky Survey are copyright © 1993-1995 by the California Institute of Technology and are distributed herein by agreement.

All material not subject to one of the above copyright provisions is copyright © 1995 by the Association of Universities for Research in Astronomy, Inc.

Produced under Contract No. NAS5-26555 with the National Aeronautics and Space Administration.

Sloan Digitized Sky Survey (SDSS)

This acknowledgment complies with the non-commercial scientific and technical publication usage of SDSS data.

Funding for the SDSS and SDSS-II has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Science Foundation, the U.S. Department of Energy, the National Aeronautics and Space Administration, the Japanese Monbukagakusho, the Max Planck Society, and the Higher Education Funding Council for England. The SDSS Web Site is http://www.sdss.org/.

The SDSS is managed by the Astrophysical Research Consortium for the Participating Institutions. The Participating Institutions are the American Museum of Natural History, Astrophysical Institute Potsdam, University of Basel, University of Cambridge, Case Western Reserve University, University of Chicago, Drexel University, Fermilab, the Institute for Advanced Study, the Japan Participation Group, Johns Hopkins University, the Joint Institute for Nuclear Astrophysics, the Kavli Institute for Particle Astrophysics and Cosmology, the Korean Scientist Group, the Chinese Academy of Sciences (LAMOST), Los Alamos National Laboratory, the Max-Planck-Institute for Astronomy (MPIA), the Max-Planck-Institute for Astrophysics (MPA), New Mexico State University, Ohio State University, University of Pittsburgh, University of Portsmouth, Princeton University, the United States Naval Observatory, and the University of Washington.

John C. Vickers
Back River Observatory
vickersjc@gmail.com
http://deepspaceccdatlas.eu.pn
Last revision: 06/30/2015.