# COMMISSION 37: STAR CLUSTERS AND ASSOCIATIONS
(AMAS STELLAIRES ET ASSOCIATIONS)

PRESIDENT: G. Lyngå
VICE-PRESIDENT: K.C. Freeman
ORGANISING COMMITTEE: T.A. Agekjan, B. Balâzs, G. Harris, D. Heggie and S. van den Bergh.

## 1. Introduction

The past triennium has been a very active period in most branches of cluster research. Some controversial subjects, notably globular cluster abundances and ages have received much attention. A good number of photometric papers on clusters as well as associations have been published. Observational effects of mass loss have been discussed by several astronomers.

This report has been assembled by the president of the commission although several sections have been contributed by other members. The report will first list some highlights in the activities of our commission. Then follow the tables containing current investigations of OB associations, open clusters and globular clusters. These have been assembled by B. Balâzs, G. Harris and R. White, respectively. After these tables comes a section by D. Heggie about dynamics of star clusters. A working group under the chairmanship of A. Moffat has made a proposal about the numbering of stars in clusters. The proposal, which is included here will be discussed by our commission at the IAU General Assembly.

I shall end this report by trying to identify a few important trends in present cluster research.

## 2. Symposia and Colloquia

A number of recent meetings have concerned our commission:

IAU Symposium No. 85, "Star Clusters", Victoria, Canada, August 1979. The proceedings have been edited by J. Hesser and are published by Reidel.

IAU Colloquium No. 59, "Effects of Mass Loss on Stellar Evolution", Trieste, Italy, September 1980. The proceedings are being edited by C. Chiosi and R. Stalio and published by Reidel.

IAU Colloquium No. 68, "Astrophysical Parameters for Globular Clusters", Schenectady, N.Y., USA, October 1981. The proceedings are being edited by A.G.D. Philip and D.S. Hayes as Dudley Observatory Report No. 15.

The following activities are planned with participation from our commission:

Joint Discussion II, at the 18th General Assembly, on "Evolution in Old Stellar Populations in Galaxies"; organiser G. Lyngå.

Joint Discussion VII, at the 18th General Assembly, on "Mass-Loss Phenomena"; organiser A.G. Hearn.

IAU Symposium No. 105, "Observational Tests of the the Stellar Evolution Theory" to be held in Geneva, Switzerland, September 1983; organiser A. Maeder.



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## 3. Review Articles and Catalogues of Data

Fundamental data on globular clusters in our own galaxy as well as in external galaxies were reviewed by Harris and Racine (26.154.017). In the same volume of Annual Reviews of Astronomy and Astrophysics, Kraft (26.154.018) presented an article about metal abundances in globular cluster stars. Also, Habing and Israel (26.132.017) discussed compact H II regions and OB star formation. Various morphological data for globular clusters were presented in Vistas of Astronomy by Alcaino (26.154.007). During 1980 there appeared two volumes of review articles as well as contributed papers: Hanes and Madore (28.003.008) edited the proceedings of a Nato Advanced Study Institute in Cambridge on globular clusters and Hesser (27.012.007) edited the volume "Star Clusters" containing material from IAU Symposium No. 85 in Victoria. The chemical composition, structure and dynamics of globular clusters were discussed by Freeman and Norris (Annual Review of Astronomy and Astrophysics 19, 319, 1981). A textbook on "Stars and Clusters" was published in 1979 by C. Payne-Gaposchkin (26.003.108).

It is gratifying to note the recent publication of the First Supplement to the Second Edition of the "Catalogue of Star Clusters and Associations" by B. Balázs, J. Ruprecht and R. White (04.153.051). The supplement, which is in three parts, can be ordered through the Publishing House of the Hungarian Academy of Sciences (Akadémiai Kiadó, P.O.B. 24, H-1363 Budapest, Hungary). The supplement itself costs \$ 65 while the 2nd edition including the supplement is \$ 100.

The Lund-Strasbourg computer based catalogue of open cluster data by G. Lyngå appeared in 1980 and was updated in 1981. It has reference No. VII-30 at the Stellar Data Centre, Strasbourg, France, and is also available through the NASA World Data Center A, Goddard Space Flight Center, Greenbelt, Maryland, USA. There is a microfiche version and a magnetic tape version of this catalogue.

A catalogue of masses and ages of stars in 68 open clusters has been provided by Piskunov (28.002.042) through the Stellar Data Centre.

## 4. Associations of Stars

B. Balázs

Papers concerning a number of associations include a study of the ultraviolet interstellar extinction by Morales, Llorente de Andrés, Ruiz del Arbol and Péres Mollá (28.131.110). Several associations of different types were investigated by Miller and Scalo (22.131.223) in their study of birthplaces of stars.

Papers and projects which refer to individual R, T and OB associations are listed in tables 1, 2 and 3, respectively. Alphabetical order has been followed and abbreviations are:

abund = chemical abundance/s/
anom = anomalous
astrom = astrometry
br = brightness
c-m = color-magnitude /diagram/
cl = cluster
d = distance/s/
distr = distribution/s/
E = color excess
em = emission
ext = extinction
IR = infrared
int = integrated
ist = interstellar
lf = luminosity function
mem = membership
mf = mass function
mol = molecular
obs = observation/s/
opt = optical
phot = photometry
pm = proper motions
pol = polarization
prop = properties
RG = red giant/s/
rv = radial velocity
Sp = spectra
str = structure
UV = ultraviolet
var = variable
vel = velocity

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TABLE 1. T ASSOCIATIONS

| Name | Observer, and type of data |
|---|---|
| Aur T1 | Salukvadze (1980) trapezium type systems |
| Cep T1 | Salukvadze (1980) trapezium type systems |
| Cha T1 | Glass (25.113.018) IR phot of stars |
| | Appenzeller (25.121.001) YY Ori stars |
| | Rydgren (27.152.004) BVRI phot, Sp, d, E, mass |
| | Arnal, Franco (27.152.013) search for HI |
| CrA T1 | Kardopolov, Filip'ev (22.113.039) UBV phot |
| | Marraco, Rydgren (1981) d and mem |
| Cyg T1 | Schmidt, Gieseking (21.152.005) RW Aur, T Tau var stars |
| | Tsvetkov (22.113.038) $H_{\alpha}$ -em stars |
| Ori T1 | Salukvadze (1980) trapezium type systems |
| Ori T2 | Salukvadze (1980) trapezium type systems |
| | Ossipkov (1981) elements of galactic orbits |
| Ori T3 | Salukvadze (1980) trapezium type systems |
| Ori T4 | Salukvadze (1980) trapezium type systems |
| Tau T1 | Salukvadze (1980) trapezium type systems |
| | Ossipkov (1981) elements of galactic orbits |
| Tau T2 | Salukvadze (1980) trapezium type systems |
| Tau T3 | Salukvadze (1980) trapezium type systems |
| | Nurmanova (1981) new member |
| | Ossipkov (1981) elements of galactic orbits |
| Tau T4 | Salukvadze (1980) trapezium type systems |

References to Table 1

Marraco, H.G., Rydgren, A.E.: 1981, Astron. J. 86, 62.
Nurmanova, U.A.: 1981, Astron. Tsirk. No. 1154, 4.
Ossipkov, L.P.: 1981, Astron. Tsirk. No. 1153, 2.
Salukvadze, G.N.: 1980, Astrofizika 16, 505.
Salukvadze, G.N.: 1980, Astrofizika 16, 687.

TABLE 2. R ASSOCIATIONS

| Name | Observer, and type of data |
|---|---|
| CMa R1 | Herbst et al. (21.152.004) opt, IR prop of new stars |
| | Reynolds, Ogden (22.134.004) Fabry-Perot obs |
| | Eggen (22.152.001) d modulus from uvbyβ obs |
| | Herbst et al. (22.152.005) opt, IR prop of new stars |
| | Whittet, Blades (27.114.038) anom diffuse bands |
| Mon R1 | Machnik et al. (25.131.199) ring str of mol cloud |
| | Kutner et al. (26.131.015) ring str of mol cloud |
| Mon R2 | White et al. (25.155.005) obs in the J=2→1 line of CO |
| | Thornson et al. (27.133.011) far-IR obs of a young cl |
| | Sargent et al. (27.152.003) molecular cloud cores |
| | Cudaback et al. (28.131.187) submillimeter and CO br |

TABLE 3. OB ASSOCIATIONS

| Name | Observer, and type of data |
|---|---|
| Ara OB1 | Herbst, Havlen (22.152.004) photometric study |
| Car OB1 | Forte (22.152.006) reddening law from UBVRI |
| | Turner et al. (28.153.008) relation to NGC 3293 |
| | Hesser, Walborn (1981) comparison of opt and UV ist lines |
| Cas OB9 | Radoslavova (22.114.046) stellar composition |
| Cas-Tau OB1 | Morales et al. (27.152.011) anom ext at 2200 Å |
| Cep OB2 | Schmidt, Gieseking (21.152.005) RW Aur, T Tau var stars |
| | Chaffee, Dunham (26.131.056) ist lines |
| Cep OB3 | Felli et al. (22.132.024) thermal radio em |
| | Sargent et al. (25.133.018) new far IR sources |
| | Sargent (26.131.052) star formation |
| | Sargent et al. (27.152.003) mol cloud cores |
| | Evans et al. (27.131.109) far-IR obs of mol cloud |
| | Lacy (22.121.045) d to eclipsing binaries |
| | Harten et al. (1981) radio continuum em |
| | Panagia, Thum (1981) relation to S155A-CepB cloud |
| | Blitz, Lada (25.131.004) $H_2O$ masers |
| Cep OB4 | Rossano et al. (27.131.179) radio obs |
| | Grayzeck (27.152.001) VRI phot |
| | Grayzeck (28.152.009) 21-cm phot |
| | Grayzeck et al. (26.152.009) kinematics |
| Cep-Lac OB1 | Radoslavova (22.114.046) stellar composition |
| CMa OB1 | Eggen (22.152.001) d modulus from uvbyβ obs |
| | Herbst (27.152.005) anatomy |
| | Reynolds, Ogden (22.134.004) Fabry-Perot obs |
| | Blitz, Lada (25.131.004) $H_2O$ masers |
| Cyg OB2 | Kleinmann et al. (21.131.153) high-resolution 2-μ Sp |
| | Souza, Lutz (27.114.013) obs of late B stars |
| | Wendker, Altenhoff (28.116.024) radio em of star No. 12 |
| Cyg OB4 | Radoslavova (22.114.046) stellar composition |
| Cyg OB6 | Souza, Lutz (27.131.206) ist line Sp |
| Lac OB1 | Kane et al. (27.114.048) C, N and O abund |
| Mon OB1 | Herbst (27.152.005) anatomy |
| | Claudius, Grosbǿl (28.152.001) mass Sp |
| Mon OB2 | Singh, Naranan (26.152.006) supernova-induced star birth |
| | Blitz, Thaddeus (28.131.251) CO obs |
| Ori OB1 | Abt, Levato (21.114.013) spectral types |
| | Warren, Hesser (21.152.002) subgroup analyses |
| | Reynolds, Ogden (21.152.006) large expanding cavity |
| | Cowie et al. (25.131.150) expanding shell of gas |
| | Guetter (26.152.008) photometric studies |
| | Shull (26.131.053) ist matter |
| | Kane et al. (27.114.048) C, N and O abund |
| | Claudius, Grosbǿl (28.152.001) mass Sp |
| | Paerels et al. (28.152.004) effect of mass loss on age |
| | Levato, Malaroda (La Plata) Sp, rv |
| | Bedijn, Tenorio-Tagle (28.152.001) formation of subgroups |
| | White, Phillips (1981) mol line obs |
| | Guetter (1981) Sp studies of stars |
| ζ Per | Duboshin et al. (21.152.001) dynamical evolution |
| Per OB2 | Schmidt, Gieseking (21.152.005) RW Aur, T Tau var stars |
| | Sargent (26.131.052) star formation |
| | Lin et al. (28.152.008) survey of em line stars |
| | Lacy (22.121.045) d to eclipsing binaries |
| | Federman (28.131.255) evidence for shocked ist gas |

TABLE 3. OB ASSOCIATIONS - continued

| Name | Observer, and type of data |
|---|---|
| Per OB 3 | Claudius, Grosbøl (28.152.001) mass Sp |
| Sco OB2 | Bystrova (26.152.007) neutral hydrogen |
| | Baart et al. (27.152.006) 2.3 GHz radio em |
| | Baart et al. (27.152.007) 2.3 GHz radio map |
| Sco OB4 | Antalová, Graham (22.131.123) ist absorption |
| Sco-Cen OB1 | Rajamohan (22.152.007) spectroscopic studies |
| | Kane et al. (27.114.048) C, N and O abund |
| | Claudius, Grosbøl (28.152.001) mass Sp |
| Sgr OB5 | Aiello et al. (26.131.035) interstellar ext |
| "Trumpler 35" | Turner (28.152.003) mem of RU Scuti |
| Vel OB1 | Turner (26.152.001) Cepheids RZ, SW vel mem? |
| Vul OB2 | Turner (27.152.001) Cepheid mem |

References to Table 3

Guetter, H.H.: 1981, Astron. J. 86, p. 1057.
Harten, R.H. et al.: 1981, Astron. Astrophys. 94, p. 231.
Hesser, J.E., Walborn, N.R.: 1981, NASA CP-2171, p. 571.
Panagia, N. and Thum, C.: 1981, Astron. Astrophys. 98, p. 295.
White, G.J. and Phillips, J.P.: 1981, Monthly Notices Roy. Astr. Soc. 194, p. 947.

## 5. Open Clusters

G. Harris

Some papers have discussed a number of open clusters, general properties of open clusters or relations between the cluster system and galactic structure. Those investigations are referred to below, in section 9.

Papers and projects which refer to individual open clusters are listed in table 4, where the clusters are ordered according to IAU number (cf section 8). Abbreviations in this table are:

abund = abundance/s/
c-m = color-magnitude /diagram/
d = distance/s/
distr = distribution/s/
E = color excess
em = emission
IR = infrared
lf = luminosity function
phot = photometry
pm = proper motions
pol = polarization
RG = red giant/s/
rv = radial velocity
Sp = spectra
str = structure
var = variable
vel = velocity

TABLE 4. OPEN CLUSTERS

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C0001-302 | Blanco 1 | Levato, Malaroda, Morrell (27.153.052) Sp |
| C0027+599 | NGC 129 | de Vegt (Hamburg) pm, space vel |
| C0039+850 | NGC 188 | Geisler, Nemec, Cannon, Hesser (D.A.O.) Sp of giants |
| C0115+580 | NGC 457 | de Vegt (Hamburg) pm, space vel |
| C0129+604 | NGC 581 | de Vegt (Hamburg) pm, space vel |
| C0132+610 | Tr 1 | Osman and Hassan (Helwan) UBV phot, E, d, age |
| C0140+604 | NGC 659 | Hassan and Osman (Riyadh) UBV phot, E, d, age |
| C0142+610 | NGC 663 | de Vegt (Hamburg) pm, space vel |

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TABLE 4. OPEN CLUSTERS - continued

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C0154+374 | NGC 752 | de Vegt (Hamburg) pm, space vel |
| C0155+552 | NGC 744 | Alksne, Alksnis (28.123.009) carbon star |
| C0211+590 | Stock 2 | de Vegt (Hamburg) pm, space vel |
| C0215+569 | NGC 869 | de Vegt (Hamburg) pm, space vel |
| | | Hill (D.A.O.) β Cephei stars |
| C0218+568 | NGC 884 | de Vegt (Hamburg) pm, space vel |
| | | Hill (D.A.O.) β Cephei stars |
| C0228+612 | IC 1805 | Burki (Geneva) UV phot, mass loss in O-stars |
| | | de Vegt (Hamburg) pm, space vel |
| C0233+557 | Tr 2 | Alksne, Alksnis (28.123.009) 2 carbon stars |
| | | de Vegt (Hamburg) pm, space vel |
| C0238+613 | NGC 1027 | de Vegt (Hamburg) pm, space vel |
| C0238+425 | NGC 1039 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |
| C0247+602 | IC 1848 | de Vegt (Hamburg) pm, space vel |
| | | Aikman (D.A.O.) Sp, rv, binaries |
| C0311+470 | NGC 1245 | Harris, Lenestor, Canterna (McMaster) UBV phot |
| C0318+484 | α Per | North, Cramer (Geneva) Ap stars |
| C0341+321 | IC 348 | de Vegt (Hamburg) pm, space vel |
| C0344+239 | Pleiades | Golay, Mauron (Geneva) UV, 7-colour phot, E, age, energy distr |
| | | Mirzoyan, Mnatsakanyan, Oganyan (27.153.085) flare stars |
| C0403+622 | NGC 1502 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |
| C0411+511 | NGC 1528 | Alksne, Alksnis (28.123.009) 3 carbon stars |
| C0417+501 | NGC 1545 | de Vegt (Hamburg) pm, space vel |
| C0424+157 | Hyades | Hauck (1981) Geneva phot, d |
| | | Upgren (22.153.015) main sequence calibration |
| | | Upgren, Weis (27.153.044) BVRI phot |
| | | Weis, DeLuca, Upgren (27.153.013) BVRI phot |
| | | Morris (D.A.O.) pm, convergent point |
| C0443+189 | NGC 1637 | de Vegt (Hamburg) pm, space vel |
| C0445+108 | NGC 1662 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C0447+436 | NGC 1664 | Alksne, Alksnis (28.123.009) carbon star |
| | | de Vegt (Hamburg) pm, space vel |
| C0525+358 | NGC 1912 | Alksne, Alksnis (28.123.009) carbon star |
| | | de Vegt (Hamburg) pm, space vel |
| C0532+341 | NGC 1960 | de Vegt (Hamburg) pm, space vel |
| C0549+325 | NGC 2099 | Alksne, Alksnis (28.123.009) carbon star |
| | | de Vegt (Hamburg) pm, space vel |
| C0604+241 | NGC 2158 | Geisler, Nemec, Cannon, Hesser (D.A.O.) Sp of giants |
| C0605+139 | NGC 2169 | de Vegt (Hamburg) pm, space vel |
| | | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| | | Hill (D.A.O.) β Cephei stars |
| C0605+243 | NGC 2168 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |
| C0613-186 | NGC 2204 | Dawson (1981) VRI, DDO phot, abund (CN) |
| C0629+049 | NGC 2244 | Marschall, Chiu, van Altena (Yale) pm |
| | | Ogura (1981) UBV phot, R, age, d, mass |
| | | de Vegt (Hamburg) pm, space vel |
| C0638+099 | NGC 2264 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |

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TABLE 4. OPEN CLUSTERS - *continued*

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C0644-206 | NGC 2287 | Feinstein, Cabrera, Clariá (22.153.028) UBVRI, DDO, d, E, age, abund, RG |
| | | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| | | North, Cramer (Geneva) Ap stars |
| C0645+411 | NGC 2281 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |
| C0649+005 | NGC 2301 | de Vegt (Hamburg) pm, space vel |
| C0705-105 | NGC 2343 | Harris, FitzGerald (Waterloo) Sp |
| C0712-102 | NGC 2353 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C0715-367 | Cr 135 | Clariá, Kepler (1980) UBV, Hα, Hβ phot, d, E, probably association |
| | | Clariá, Escosteguy (25.123.066) var stars |
| C0716-248 | NGC 2362 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C0722-321 | Cr 140 | Clariá (27.153.084) UBV, Hβ, DDO phot, Sp, rv, d, E, age, abund |
| | | FitzGerald, Harris, Miller (27.153.006) UBV phot, Sp, rv, d, E |
| | | Lyngå (Lund) uvby, Hβ |
| C0724-476 | Mel 66 | Dawson (22.113.042) DDO phot, abund (CN) |
| | | Hesser, McClure (D.A.O.) phot |
| | | McClure (D.A.O.), Twarog, Twarog (Yale) age |
| C0734-143 | NGC 2422 | North, Cramer (Geneva) Ap stars |
| C0735+216 | NGC 2420 | Archemashvili (26.153.028) str, lf |
| C0740-354 | Ru 31 | Clariá (Cordoba) UBV phot |
| C0743-378 | NGC 2451 | Lyngå (Lund) uvby, Hβ |
| C0750-384 | NGC 2477 | Hesser, Smith (27.153.036) Sp, phot |
| C0752-241 | NGC 2482 | Clariá, Lapasset (Cordoba) CMT1T2, UBV phot, RG |
| C0757-106 | NGC 2506 | Chiu, van Altena (1981) pm |
| | | McClure (D.A.O.), Twarog (Yale) c-m, metallicity |
| C0757-607 | NGC 2516 | Guthrie (Edinburgh) rotation vel |
| | | King (25.111.029) pm |
| | | Lyngå (Lund) uvby, Hβ |
| | | North, Cramer (Geneva) Ap stars |
| C0802-461 | Cr 173 | Lyngå (Lund) uvby, Hβ |
| C0809-491 | NGC 2547 | Clariá (Cordoba) UBV, Hβ phot, main sequence gap, E, d, age |
| | | Clariá, Escosteguy (25.123.066) var stars |
| | | Lyngå (Lund) uvby, Hβ |
| C0810-374 | NGC 2546 | FitzGerald, Harris (Waterloo) Sp |
| C0837+201 | NGC 2632 | Cudworth, Jones (Yerkes) pm |
| | (Praesepe) | de Vegt (Hamburg) pm, space vel |
| | | Hauck (1981) Geneva phot, d |
| | | Levato, Malaroda (La Plata) Sp |
| | | Upgren, Weis, DeLuca (26.153.013) BVRI phot |
| | | Upgren, Weis (27.153.044) BVRI phot |
| C0838-528 | IC 2391 | King (1980a) pm |
| | | Lyngå (Lund) uvby, Hβ |
| | | North, Cramer (Geneva) Ap stars |
| C0840-469 | NGC 2660 | Hesser, Smith (27.153.036) Sp, phot |
| C0843-527 | NGC 2669 | King (1980a) pm |
| C0846-423 | Tr 10 | Lyngå (Lund) uvby, Hβ |
| C0847-120 | NGC 2682 | Archemashvili (27.153.055) str, lf |
| | (M67) | de Vegt (Hamburg) pm, space vel |

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TABLE 4. OPEN CLUSTERS - continued

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C0920-509 | Pis 13 | Clariá (26.153.017) UBV phot, d, absorption |
| | | Clariá, Escosteguy (25.123.066) var stars |
| C0921-770 | E3 | McClure, Cannon, Hawarden, Hesser (D.A.O.) BV phot |
| C0926-567 | IC 2488 | King (Sydney) pm |
| C1001-579 | Lodén 28 | Lodén (1981) UBV phot, E, d, age |
| C1001-598 | NGC 3114 | North, Cramer (Geneva) Ap stars |
| C1003-555 | Lodén 1 | Lodén (27.152.012) UBV phot |
| C1025-573 | IC 2581 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1025-602 | Lodén 172 | Lodén (26.153.025) uvby, Hβ, UBV phot, Sp, E, d |
| C1027-565 | Lodén 89 | Lodén (26.153.025) uvby, UBV phot, Sp, E, d |
| C1032-615 | Lodén 213 | Lodén (27.152.012) UBV, uvby phot, E, d |
| C1033-579 | NGC 3293 | Clariá, Escosteguy (25.123.066) var stars |
| | | Feinstein, Marraco (28.153.001) UBVRI phot, d, age, E, em line stars, pol |
| C1040-588 | Bo 10 | Feinstein (1981) UBVRI phot, d, E, age |
| C1041-641 | IC 2602 | North, Cramer (Geneva) Ap stars |
| C1041-597 | Cr 228 | Levato, Malaroda (La Plata) Sp |
| | | Thé, Bakker, Antalova (27.153.060) Walraven phot, d |
| | | Thé, Bakker, Tjin A Djie (28.131.088) UBVRIJHKLM phot, R |
| C1041-593 | Tr 14 | Feinstein (La Plata) UBV phot |
| | | Levato, Malaroda (La Plata) Sp |
| | | Thé, Bakker, Antalova (27.153.060) Walraven phot, d |
| | | Thé, Bakker, Tjin A Djie (28.131.088) UBVRIJHKLM phot, R |
| C1042-591 | Tr 15 | Feinstein, FitzGerald, Moffat (27.153.066) UBVRI phot, d, E, age, red supergiants |
| | | Levato, Malaroda (La Plata) Sp |
| | | Thé, Bakker, Antalova (27.153.060) Walraven phot, d |
| C1043-594 | Tr 16 | Feinstein (La Plata) UBVRI phot |
| | | Forte (La Plata) UBV phot |
| | | Levato, Malaroda (La Plata) Sp |
| | | Thé, Bakker, Antalova (27.153.060) Walraven phot, d |
| | | Thé, Bakker, Tjin A Djie (28.131.088) UBVRIJHKLM phot, R |
| | | Thé, Tjin A Djie, Kudritzki, Wesselius (28.114.100) energy distr of HD 93250 |
| C1048-560 | Lodén 189 | Lodén (26.153.025) UBV phot, Sp, E, d |
| C1104-584 | NGC 3532 | Fernández, Salgado (27.153.002) UBV phot, d, age, mass |
| C1104-608 | Lodén 306 | Lodén (27.152.012) UBV, uvby phot, E, d |
| C1108-599 | NGC 3572 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1109-600 | Cr 240 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1109-604 | Tr 18 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1110-586 | Stock 13 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C1123-429 | NGC 3680 | Clariá, Lapasset (Cordoba) CMT1T2, UBV phot, RG |
| C1130-604 | Lodén 402 | Lodén (27.152.012) UBV phot, E, d |
| C1147-609 | Lodén 481 | Lodén (26.153.025) UBV phot, Sp, E, age |
| C1148-554 | NGC 3960 | Janes (1981) BV, DDO phot, E, d, age, abund (CN) |
| C1204-609 | NGC 4103 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| | | King (1979) pm |
| C1221-616 | NGC 4349 | Dawson (22.113.042) DDO phot, abund (CN) |
| C1222+263 | Mel 111 | DeLuca, Weis (1981) BVRI phot |
| | (Coma) | Hauck (1981) Geneva phot, d |
| | | Mayor, Mermilliod (27.153.039) rv, binaries, rotation |
| | | North, Cramer (Geneva) Ap stars |
| C1227-645 | NGC 4463 | FitzGerald, Harris (Waterloo) UBV phot, Sp |

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TABLE 4. OPEN CLUSTERS - continued

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C1232+365 | Upgren 1 | Upgren, Philip, Beavers (Van Vleck) uvby phot, r, d, age |
| C1239-627 | NGC 4609 | Lodén (26.153.025) UBV, uvby, Hβ phot, Sp, E, d |
| C1244-603 | Lodén 682 | Lodén (27.152.012) UBV phot |
| C1250-600 | NGC 4755 | King (1981) pm |
| C1250-605 | Lodén 694 | Lodén (27.152.012) UBV phot, E, d |
| C1321-594 | Lodén 821 | Lodén (27.152.012) UBV phot, E, d |
| C1324-587 | NGC 5138 | Clariá (28.153.013) UBV, DDO phot, E, d, abund (CN), age |
| | | Clariá, Escosteguy (25.123.066) var stars |
| C1329-644 | Lodén 848 | Lodén (26.153.025) UBV, Hβ phot, Sp, E, d |
| C1330-590 | Lodén 915 | Lodén (1981) UBV phot, E, d, age |
| C1343-626 | NGC 5281 | Harris, FitzGerald (Waterloo) Sp |
| C1348-645 | Lodén 995 | Lodén (26.153.025) UBV, Hβ, Sp, E, d |
| C1350-616 | NGC 5316 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C1413-579 | Lodén 1289 | Lodén (26.153.025) UBV, uvby phot, Sp, E, d |
| C1420-611 | Ly 2 | Lodén (26.153.012) UBV phot |
| C1424-579 | Lodén 1378 | Lodén (26.153.025) UBV, uvby, Hβ phot, Sp, E |
| C1424-594 | NGC 5606 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C1431-563 | NGC 5662 | King (1980b) pm |
| C1445-543 | NGC 5749 | FitzGerald, Harris (Waterloo) UBV phot, Sp |
| C1500-541 | Lodén 2104 | Lodén (26.153.025) UBV, uvby phot, Sp, E, d |
| C1501-541 | NGC 5822 | Anthony-Twarog, Chiu (Yale) pm |
| | | Dawson (22.113.042) DDO phot, abund (CN) |
| C1502-554 | NGC 5823 | Dawson (22.113.042) DDO phot, abund (CN) |
| | | Janes (1981) BV, DDO phot, E, d, age, abund (CN) |
| C1504-584 | Lodén 2045 | Lodén (26.153.025) UBV, Hβ phot, Sp, E, d |
| C1529-579 | Lodén 2159 | Lodén (27.152.012) UBV, uvby phot, E, d |
| C1537-522 | Lodén 2313 | Lodén (27.152.012) UBV phot |
| C1559-603 | NGC 6025 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| | | Levato, Malaroda (La Plata) Sp |
| C1614-577 | NGC 6087 | King (Sydney) pm |
| C1636-432 | NGC 6192 | Kilambi, FitzGerald (Waterloo) UBV phot, Sp |
| C1637-486 | NGC 6193 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1650-417 | NGC 6231 | Levato, Malaroda (28.153.002) Sp |
| C1701-378 | NGC 6281 | North, Cramer (Geneva) Ap stars |
| C1714-429 | NGC 6322 | Harris, FitzGerald (Waterloo) UBV phot, Sp |
| C1720-499 | IC 4651 | Clariá, Lapasset (Cordoba) CMT1T2, UBV phot, RG |
| C1731-325 | NGC 6383 | Miller (Waterloo) UBV phot, Sp, Schmidt Sp, rv |
| C1732-334 | Tr 27 | Bakker, Thé (Amsterdam) Walraven phot, E, d |
| | | Thé, Tjin A Djie (27.112.005) Walraven phot, IR excess, Sp of star Tr 27-28 |
| | | van der Hucht, Thé, Bakker (1980) $M_V$ of Tr 27-28 |
| C1736-321 | NGC 6405 | North, Cramer (Geneva) Ap stars |
| C1743+057 | IC 4665 | de Vegt (Hamburg) pm, space vel |
| C1750-348 | NGC 6475 | North, Cramer (Geneva) Ap stars |
| C1806-240 | Cr 367 | Clariá, Lapasset (Cordoba) UBV phot |
| C1816-138 | NGC 6611 | Feinstein (La Plata) UBVRI |
| | | Levato, Malaroda (La Plata) Sp |
| | | Westerlund (Uppsala) Sp faint stars |
| C1825+065 | NGC 6633 | de Vegt (Hamburg) pm, space vel |
| | | North, Cramer (Geneva) Ap stars |
| C1836+054 | IC 4756 | de Vegt (Hamburg) pm, space vel |

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TABLE 4. OPEN CLUSTERS - continued

| Cluster IAU number | Old notation | Observer, and type of data |
|---|---|---|
| C1919+377 | NGC 6791 | Geisler, Nemec, Canterna, Hesser (D.A.O.) phot, Sp |
| | | Harris, Canterna (1981) UBV phot, E, d, age, metallicity |
| | | Janes (Boston) DDO phot, E, abund (CN) |
| C2004+356 | NGC 6871 | de Vegt (Hamburg) pm, space vel |
| C2030+604 | NGC 6939 | Harris, Lenestor, Canterna (McMaster) UBV phot |
| C2032+281 | NGC 6940 | de Vegt (Hamburg) pm, space vel |
| C2130+482 | NGC 7092 | de Vegt (Hamburg) pm, space vel |
| C2144+655 | NGC 7142 | Kopylov, Samuš, Shugarov (1980) c-m, d |
| C2151+470 | IC 5146 | Forte, Orsatti (La Plata) UBVRI phot |
| C2152+623 | NGC 7160 | de Vegt (Hamburg) pm, space vel |
| C2203+462 | NGC 7209 | de Vegt (Hamburg) pm, space vel |
| C2245+578 | NGC 7380 | de Vegt (Hamburg) pm, space vel |
| C2354+564 | NGC 7789 | Alksne, Alksnis (28.123.009) 2 carbon stars |
| | | Clariá (26.153.024) E, abund ([Fe/H]), $T_e$, g, mass for 19 giants |
| | | Clariá (27.153.083) UBV, DDO phot, E, abund, mass loss |
| | | Geisler, Nemec, Cannon, Hesser (D.A.O.) phot, Sp |
| C2252+605 | NGC 7419 | Moffat (Montréal) Sp |

References to Table 4

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King, D.S.: 1980b, Sydney Obs. Papers No. 87.
King, D.S.: 1981, Sydney Obs. Papers No. 89.
Kopylov, A.I., Samuš, N.N. and Shugarov, S.Yu.: 1980, Astron. Tsirk. No. 1129, p. 3.
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## 6. Globular Clusters

R. E. White

The triennial synopsis of published work concerning the globular star clusters, see Tables 5A, 5B, and 5C, has been compiled from Volumes 21 - 28, inclusive, of the Astronomy and Astrophysics Abstracts; none of the already-extensive 1981 literature has been included in the tables because of the space limitations imposed upon these Reports. For the same reason, no summary of the many reports of work-in-progress is given here. This author thanks those colleagues who sent in such reports as they are useful documents to him for keeping abreast of work yet to be incorporated in subsequent triennial listings. As customary, reports on variable star research within the clusters will be found in the Commission 27 Report ("Variable Stars"), written by Dr. H. Sawyer-Hogg.

The explosion of information concerning globular clusters reflects their astrophysical importance not only as test-beds for theories of stellar evolution, but also as enigmatic objects in their own right: some contain sources of X-ray emission while others exist as contradictory examples to established patterns of evolution. Throughout, the impact of the large Southern Hemispheric telescopes on all of the aspects of globular cluster research has been, and promises to continue to be, profound. Noteworthy at this time is the entry into the field of observers using the Soviet Union's 6-m telescope, particularly with regard to the research programs onclusters in other galactic systems of our Local Group.

The many symposia and collquia concerning the globular star clusters have been mentioned already, in Section 2. of this Report, together with the subsequently published proceedings thereof; in Section 3. are listed the important review articles and reports of summer institutes, etc.

The principal research emphasis over the past three years has pertained to the discovery of chemical abundance anomalies in individual stars of specific globular clusters. The conventional picture of stellar evolution out of a chemically homogeneous cluster environment has been brought seriously into question by the spectroscopic results on individual stars obtained with the use of 4-m class telescopes. As mentioned before, the Soviet astronomers have promptly turned their new 6-m telescope onto the systems of star clusters found associated with such galaxies as M 31 and M 33.

Apparent chemical inhomogeneity problems are further compounded by certain of the clusters having been discovered as being sources of X-ray emission. The cluster X-ray sources had just been announced at the time of the last triennial report; the past three years have been useful in verifying and extending the occurrence of the phenomenon. The quantum leap in numbers of publications concerning the clusters is due in part to this exploitation of a new class of object in association with them. The Harvard/M.I.T. X-ray group discovered a new type of X-ray source, called a "burster", in the cluster C1820-303 (NGC 6624), and which type of object has now been seein in a second cluster, C1724-307 (Terzan 2); C1730-333 (Liller 1) apparently participates in infrared "bursts."

Beginning with this triennial report, the relevant data of Tables 5A, B, and C will be kept up-to-date as new volumes of the Abstracts journal are received. People interested in obtaining a literature list for specific clusters should make their request for a copy known to this author; address: Dr. R. E. White, Steward Observatory, University of Arizona, Tucson, Arizona 85721, U.S.A. The abbreviations used in the following tables are consistent with those specified by Balàzs and by G. Harris earlier in this Report.

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TABLE 5A - Published Information by Cluster

C0021-723 (NGC 104, 47 Tuc)
Bell et al. (22.113.028)- var. in CN-str.
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Boehm-Vitense (26.064.050)- He-abund. influences on late-type sp.
Carney (27.154.070)- age and dist.
Chun & Freeman (21.154.026)- CMD of inner part
DaCosta (25.154.014)- surface-br. profile
Dickens et al. (26.154.005)- CN abund. in rG st.
Dupree et al. (25.154.017)- uv sp.
Gustaffason & Ardeberg (22.113.027)- comparison of theory to RHB st.
Hartwick & McClure (27.113.001)- rG st. CN-indices via DDO phot.
Hesser (22.114.004)- CN var. in 80 st. br. than B= +18.2
Hesser & Bell (27.114.201)- CN-abund. var. from sp. of 7 upper MS st.
Keith & Butler (27.154.005)- memb. and metallicity of 3 RR Lyr st.
Mallia (22.154.021)- sp. of AGB st.
Norris & Cottrell (25.154.012)- CN-str. of 2 AGB st.
Norris & Freeman (25.154.021)- CN distrib. from 142 rG st. sp.
Pilachowski et al. (27.154.001)- c.c. comp. to old disk cl. NGC 2420
Smith, H.A. (25.154.007)- abund. grad. in cl.
Welch & Code (27.154.018)- OAO energy distrib.

C0050-268 (NGC 288)
Alcaino & W. Liller (28.154.043)- CMD to MS
Samus' & Shugarov (25.154.030)- faint st. phot.
Welch & Code (27.154.018)- OAO energy distrib.

C0100-711 (NGC 362)
Welch & Code (27.154.018)- OAO energy distrib.

C0310-554 (NGC 1261)
Alcaino (26.154.008)- CMD
Welch & Code (27.154.018)- OAO energy distrib.

C0325+794 (Pal 1)
Cowley et al. (21.114.010)- sp. of rG st.

C0354-498 (AM 1)
Madore & Arp (25.154.005)- discovery

C0422-213 (Eri 1)
West & Bartaya (26.154.009)- sp. and integr. UBV p.e. phot.

C0443+313 (Pal 2)
Cowley et al. (21.114.010)- sp. of rG st.
Harris (27.154.062)- dist. and structural properties

C0512-400 (NGC 1851)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Dupree et al. (25.154.017)- uv sp.
IAU Circ. 3209 and 3226 (21.154.032)- detection of neutral H I
Jernigan & Clark (26.154.002)- location of X-ray source
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"
Smith, H.A. (27.154.065)- chem. abund. gradient
Strauss (22.154.011)- multi-color strip phot.
Welch & Code (27.154.018)- OAO energy distrib.

C0522-245 (NGC 1904, M 79)
Strauss (22.154.011)- multi-color strip phot.
Troland et al. (21.154.004)- unsuccesful search for CO
Welch & Code (27.154.018)- OAO energy distrib.

C0647-359 (NGC 2298)
van Albada et al. (25.154.020)- ANS far-uv phot.

C0734+390 (NGC 2419)
Canterna & Schommer (21.154.005)- chem. abund.
Troland et al. (21.154.004)- unsuccesful search for CO

C0737-337 (AM 2)
Madore & Arp (25.154.005)- discovery

C0911-646 (NGC 2808)
Harris (21.154.021)- p.e. UBV and DDO phot.
Strauss (22.154.011)- multi-color strip phot.

C0921-770 (E 3)
van den Bergh et al. (28.154.002)- st.-poor cl.

C1003+003 (Pal 3)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.

C1126+292 (Pal 4)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.

C1310+184 (NGC 5024, M 53)
Dickey & Malkan (27.154.016)- search for OH-em.
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs.
at 2.7, 4.8, and 10.7 GHz
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
van Albada et al. (25.154.020)- ANS far-uv phot.

C1313+179 (NGC 5053)
Canterna & Schommer (21.154.005)- chem. abund.
Dickey & Malkan (27.154.016)- search for OH-em.

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C1323-472 (NGC 5139, ω Cen)
Boehm-Vitense (26.064.050)- He-abund. influences on late-type sp.
Cannon (27.154.004)- faint nebl. near cl.
DaCosta (25.154.014)- surface-br. profile
Mallia & Pagel (22.064.030)- evidence for mass loss from rG st.
Persson et al. (27.154.002)- IR obs. of 82 rG st., spread in CC abs.
Rodgers et al. (26.114.012)- rG st. [Fe/H] and S values from intermed. band obs.
Rodgers & Newell (28.034.001)- SEC Vidicon phot. of MS st.
Welch & Code (27.154.018)- OAO energy distrib.

C1339+286 (NGC 5272, M 3)
Bell & Dickens (28.154.042)- chem. abund. via sp. synthesis
Bendinelli et al. (21.154.042)- p.e. scan of core
Carney (27.154.070)- age and dist.
Christensen (21.114.039)- abs. sp. energy distrib.
Cohen (J.) (21.114.565)- detailed abund. anal. of 3 rG st.
Cohen (J.) et al. (21.113.042)- IR pe phot.; rG st. m(bol) and T(e)
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Cudworth (26.154.014)- p.m. and memb. prob. for 266 st.
Dickey & Malkan (27.154.016)- search for OH-em.
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
Gunn & Griffin (25.154.032)- rv (+ 1 km/s) for 111 rG and AGB st.
Kanagy & Wyatt (22.154.001)- dust patches
Mould & McElroy (21.154.010)- TiO band str.
Pilachowski (22.154.010)- CO in rG st.
Pilachowski et al. (27.154.006)- CC of rG st.
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
Schneps et al. (22.154.029)- CO search
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Spasaova (21.154.041)- p.m. of br. rG st.
Suntzeff (27.154.025)- Ca-abund. correlated with [Fe/H]
Troland et al. (21.154.004)- unsuccesful search for CO
Welch & Code (27.154.018)- OAO energy distrib.

C1343-511 (NGC 5286)
Fourcade, Laborde & Aria (27.115.003)- CMD

C1403+287 (NGC 5466)
Dickey & Malkan (27.154.016)- search for OH-em.

C1500-328 (NGC 5824)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content

C1514-208 (NGC 5897)
Welch & Code (27.154.018)- OAO energy distrib.

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C1516+022 (NGC 5904, M 5)
Carney (27.154.070)- age and dist.
Christensen (21.114.039)- abs. sp. energy distrib.
Cudworth (26.154.024)- p.m. and memb. prob. for 317 st.
Dickey & Malkan (27.154.016)- search for OH-em.
Pike (21.154.018)- DDO electronog. obs.
Pilachowski (22.154.010)- CO in rG st.
Pilachowski et al. (27.154.006)- CC of rG st.
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Welch & Code (27.154.018)- OAO energy distrib.

C1524-505 (NGC 5927)
Alcaino (25.154.034)- CMD
Bowers et al. (26.154.015)- 1612 MHz obs. for gas content

C1531-504 (NGC 5946)
Martins & Harvel (26.154.011)- UBVR pe seq.

C1542-376 (NGC 5986)
Strauss (22.154.011)- multi-color strip phot.
Welch & Code (27.154.018)- OAO energy distrib.

C1608+150 (Pal 14)
Cowley et al. (21.114.010)- sp. of rG st.

C1614-228 (NGC 6093, M 80)
Schneps et al. (22.154.029)- CO search
Strauss (22.154.011)- multi-color strip phot.

C1620-264 (NGC 6121, M 4)
Mould et al. (25.154.010)- TiO band-str. of reddest st.
Schneps et al. (22.154.029)- CO search
Welch & Code (27.154.018)- OAO energy distrib.

C1624-259 (NGC 6144)
Alcaino (27.154.009)- CMD

C1629-129 (NGC 6171, M 107)
Mould & McElroy (21.154.010)- TiO band str.
Pilachowski (22.154.010)- CO in rG st.
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Troland et al. (21.154.004)- unsuccesful search for CO

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C1639+365 (NGC 6205, M 13)
Bell & Dickens (28.154.042)- chem. abund. via sp. synthesis
Carney (27.154.070)- age and dist.
Christensen (21.114.039)- abs. sp. energy distrib.
Cohen (J.) (21.114.565)- detailed abund. anal. of 3 rG st.
Cohen (J.) et al. (21.113.042)- IR pe phot.; rG st. m(bol) and T(e)
Cudworth (26.154.010)- p.m. and memb. prob., non-Yerkes plates
Cudworth & Monet (25.154.033)- p.m. and memb. prob., Yerkes plates
Dickey & Malkan (27.154.016)- search for OH-em.
Geraschenko & Kadla (25.154.006)- st. distrib. in central region
Griffin (25.114.036)- differential curve-of-growth [m/H] for rG st., L973
Kanagy & Wyatt (22.154.001)- dust patches
Mould & McElroy (21.154.010)- TiO band str.
Peterson, R.(27.154.066)- rG st. Na-abund. var.
Pilachowski (22.154.010)- CO in rG st.
Pilachowski et al. (27.154.006)- CC of rG st.
Schneps et al. (22.154.029)- CO search
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Spasaova (21.154.040)- p.m. of br. rG st.
Suntzeff (27.154.025)- Ca-abund. correlated with [Fe/H]
van Albada et al. (25.154.020)- ANS far-uv phot.
Welch & Code (27.154.018)- OAO energy distrib.

C1644-018 (NGC 6218, M 12)
Buonanno et al. (21.154.035)- apparent distrib. of st.
Gratton & Nesci (21.154.009)- rv (-44 km/s) of cl. from indiv. st.
Mironov, Samus' & Shugarov (25.154.025)- instr. CMD
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Welch & Code (27.154.018)- OAO energy distrib.

C1650-220 (NGC 6235)
Liller, M.(27.154.071)- CMD

C1654-040 (NGC 6254, M 10)
Buonanno et al. (21.154.035)- apparent distrib. of st.
Gratton (28.154.017)- anal. of low-disp. sp. of rG st.
Gratton & Nesci (21.154.009)- rv (+67 km/s) of cl. from indiv. st.
Mould & McElroy (21.154.010)- TiO band str.
Pilachowski (22.154.010)- CO in rG st.
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Welch & Code (27.154.018)- OAO energy distrib.

C1656-370 (NGC 6256)
Alcaino (22.154.003)- CMD

C1658-300 (NGC 6266)
Alcaino (21.154.028)- CMD

C1659-262 (NGC 6273, M 19)

Strauss (22.154.011)- multi-color strip phot.

C1702-226 (NGC 6287)
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities

C1711-294 (NGC 6304)
Mould et al. (25.154.010)- TiO band-str. of reddest st.

C1715+432 (NGC 6341, M 92)
Bell et al. (22.113.028)- Carbon underabund. in st. br. than M(V)= -0.7
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Carney (27.154.070)- age and dist.
Christensen (21.114.039)- abs. sp. energy distrib.
Cohen (J.) (26.114.007)- LTE line-blanketed model atmosph. abund. anal. of 4 st.
Cohen (J.) et al. (21.113.042)- IR pe phot.; rG st. m(bol) and T(e)
Cowley et al. (21.114.010)- sp. of rG st.
Dickens & Gustaffson (25.154.011)- rG st. Carbon abund.
Dupree et al. (25.154.017)- uv sp.
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
Gratton & Nesci (21.154.009)- cl. rv estimated from 3 indiv. st.
Pilachowski (22.154.010)- CO in rG st.
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Spasova (21.154.041)- p.m. of br. rG st.
Suntzeff (27.154.025)- Ca-abund. correlated with [Fe/H]
Troland et al. (21.154.004)- unsuccesful search for CO
van Albada et al. (25.154.020)- ANS far-uv phot.
Welch & Code (27.154.018)- OAO energy distrib.

C1716-184 (NGC 6333, M 9)
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Strauss (22.154.011)- multi-color strip phot.

C1720-177 (NGC 6356)
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search

C1724-307 (Terzan 2)
Grindlay (22.142.026)- possible X-ray source
Grindlay et al. (28.154.012)- image of an X-ray burst
Malkan et al. (27.154.063)- IR phot.

C1730-333 (Liller 1, MXB1730-333)
Apparao & Chitre (26.154.014)- IR bursts
Malkan et al. (27.154.063)- IR phot.

C1732-447 (NGC 6388)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Strauss (22.154.011)- multi-color strip phot.

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C1736-536 (NGC 6397)
Alcaino & W.Liller (27.154.072)- CMD to MS
Bell et al. (22.113.028)- Carbon underabund. in st. br. than M(V)= -0.7
DaCosta (25.154.014)- surface-br. profile
Dickens & Gustaffson (25.154.011)- rG st. Carbon abund.
Mallia (22.154.021)- sp. of AGB st.
Mould et al. (25.154.010)- TiO band-str. of reddest st.
van Albada et al. (25.154.020)- ANS far-uv phot.

C1735-032 (NGC 6402, M 14)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Mould et al. (25.154.010)- TiO band-str. of reddest st.
Welch & Code (27.154.018)- OAO energy distrib.

C1742+031 (NGC 6426)
Dickey & Malkan (27.154.016)- search for OH-em.

C1746-203 (NGC 6440)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
Martins et al. (27.154.064)- surface phot.
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"
Troland et al. (21.154.004)- unsuccesful search for CO
Williams & N.Bahcall (26.154.006)- br.-, density- , and color-profiles

C1746-370 (NGC 6441)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Jernigan & Clark (26.154.002)- location of X-ray source
Martins & Harvel (26.154.011)- UBVR pe seq.
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"
Strauss (22.154.011)- multi-color strip phot.

C1751-241 (UKS 1)
Malkan et al. (27.154.063)- IR phot.

C1801-003 (NGC 6535)
Liller, M.(28.154.023)- BV CMD

C1801-300 (NGC 6528)
van den Bergh & Younger (26.154.013)- CMD, E(B-V); r, z

C1804-437 (NGC 6541)
Alcaino (25.154.002)- CMD
van Albada et al. (25.154.020)- ANS far-uv phot.
Williams & N.Bahcall (26.154.006)- br.-, density-, and color-profiles

C1806-259 (NGC 6553)
Bowers et al. (26.154.015)- 1612 MHz obs. for gas content
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search

C1820-303 (NGC 6624)
Canizares et al. (22.154.008)- ptg., pe, and sp.
Dupree et al. (25.154.017)- uv sp.
Jernigan & Clark (26.154.002)- location of X-ray source
Liller (M.) & Carney (22.142.020)- CMD
Martins & Harvel (26.154.011)- UBVR pe seq.
Martins & Harvel (27.154.007)- surface phot.
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"
Smith, H.A. (27.154.065)- chem. abund. gradient
Troland et al. (21.154.004)- unsuccesful search for CO

C1821-249 (NGC 6626, M 28)
Baddiley (27.154.015)- integr. IR phot.
Mould et al. (25.154.010)- TiO band-str. of reddest st.
Strauss (22.154.011)- multi-color strip phot.

C1828-323 (NGC 6637, M 69)
Mould et al. (25.154.010)- TiO band-str. of reddest st.
Strauss (22.154.011)- multi-color strip phot.

C1833-239 (NGC 6656, M 22)
Baddiley (27.154.015)- integr. IR phot.
Boehm-Vitense (26.064.050)- He-abund. influences on late-type sp.
Evans (T.L.) (21.154.002)- rv obs. for memb.
Hesser & Harris (G.) (26.154.023)- 15 new rv memb., second CH st.
Mallia (22.154.021)- sp. of AGB st.
Mallia & Pagel (22.064.030)- evidence for mass loss from rG st.
Mould et al. (25.154.010)- TiO band-str. of reddest st.
Rudy & Willner (27.114.145)- CO-abund. in CH st. III-106
Schneps et al. (22.154.029)- CO search
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
van Albada et al. (25.154.020)- ANS far-uv phot.
Welch & Code (27.154.018)- OAO energy distrib.

C1840-323 (NGC 6681, M 70)
van Albada et al. (25.154.020)- ANS far-uv phot.

C1850-087 (NGC 6712)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
Jernigan & Clark (26.154.002)- location of X-ray source
Liller (W.) (22.142.200)- X-ray source optical counterpart candidate
Mould & McElroy (21.154.010)- TiO band str.
Remillard et al. (28.126.019)- discovery of sdO st.
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"

C1851-305 (NGC 6715, M 54)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Strauss (22.154.011)- multi-color strip phot.
Welch & Code (27.154.018)- OAO energy distrib.

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C1852-227 (NGC 6717, Pal 9)
Goranskij (25.154.023)- CMD

C1856-367 (NGC 6723)
Welch & Code (27.154.018)- OAO energy distrib.

C1902+017 (NGC 6749)
Dickey & Malkan (27.154.016)- search for OH-em.

C1906-600 (NGC 6752)
Bell & Dickens (28.154.042)- chem. abund. via sp. synthesis
Carney (25.154.014)- UBV CMD to MS
Carney (27.154.070)- age and dist.
DaCosta (25.154.014)- surface-br. profile
DaCosta & Cottrell (27.154.008)- CN-abund. via sp. synthesis
Dupree et al. (25.154.017)- uv sp.
Mallia (22.154.021)- sp. of AGB st.
Mallia & Pagel (22.064.030)- evidence for mass loss from rG st.
Newell & Sadler (21.154.019)- bluest st. in cl. analagous to sdB st.
Richer (22.126.003)- evidence for wd st.
Richer & Olson (28.141.171)- 25 faint GSO candidates, one confirmed by sp.
van Albada et al. (25.154.020)- ANS far-uv phot.

C1908+009 (NGC 6760)
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Dickey & Malkan (27.154.016)- search for OH-em.

C1914+300 (NGC 6779, M 56)
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Dickey & Malkan (27.154.016)- search for OH-em.
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities

C1916+184 (Pal 10)
Dickey & Malkan (27.154.016)- search for OH-em.

C1936-310 (NGC 6809, M 55)
van Albada et al. (25.154.020)- ANS far-uv phot.
Welch & Code (27.154.018)- OAO energy distrib.

C1942-081 (Pal 11)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.

C1951+186 (NGC 6838, M 71)
Carney (27.154.070)- age and dist.
Cohen (J.) (28.154.025)- high-disp. sp. of 4 rG st. vs. old open cl. rG st.
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Cowley et al. (21.114.010)- sp. of rG st.
Dickey & Malkan (27.154.016)- search for OH-em.
Frogel et al. (25.154.004)- 25 rG and HB st. IR col. and CO band-str.
Gratton (28.154.017)- anal. of low-disp. sp. of rG st.
Gratton & Nesci (21.154.009)- rv (-19 km/s) of cl. from indiv. st.
Mould & McElroy (21.154.010)- TiO band str.
Pilachowski (22.154.010)- CO in rG st.

C2003-220 (NGC 6864, M 75)
Baddiley (27.154.015)- integr. IR phot.
Strauss (22.154.011)- multi-color strip phot.
Welch & Code (27.154.018)- OAO energy distrib.

C2050-127 (NGC 6987, M 72)
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content

C2059+160 (NGC 7006)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.
Dickey & Malkan (27.154.016)- search for OH-em.
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources

C2127+119 (NGC 7078, M 15)
Auriere et al. (21.154.006)- [O III] emission search
Baddiley (27.154.015)- integr. IR phot.
Bowers et al. (26.154.015)- 21-cm. and 1612 MHz obs. for gas content
Calvani, Nobili & Turolla (28.154.024)- st. counts on UBV plates
Carney (27.154.070)- age and dist.
Christensen (21.114.039)- abs. sp. energy distrib.
Cohen (J.) (26.114.007)- 2 st. anal. by LTE line-blanketed model atmosph.
Cohen (N.) & Malkan (25.154.003)- H2O maser em. search
Cowley et al. (21.114.010)- sp. of rG st.
Dickey & Malkan (27.154.016)- search for OH-em.
Dupree et al. (25.154.017)- uv sp.
Feibelmann (21.154.030)- nucleus br. profile
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
IAU Circ.No.3306 (22.114.561)- var. em.-line st. in core
Jernigan & Clark (26.154.002)- location of X-ray source
Kanagy & Wyatt (22.154.001)- dust patches
Mochnacki & Walker (22.154.013)- BVR areal phot.
Newell & O'Neil (22.154.012)- surface br. distrib.
Phillips et al. (22.154.033)- H and 6700 electronogr. of core
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
Rusev & Kolotilov (25.154.031)- core H -em. search
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
Shawl & R.E.White (28.154.004)- eq. coord. of cl. center to ± 1"
Spasova (28.154.044)- uv-br. object in cl. center
Suntzeff (27.154.025)- Ca-abund. correlated with [Fe/H]
Troland et al. (21.154.004)- unsuccesful search for CO

C2130-010 (NGC 7089, M 2)
Baddiley (27.154.015)- integr. IR phot.
Gopal-Krishna & Steppe (28.141.024)- radio continuum obs. at 2.7, 4.8, and 10.7 GHz
Rood (R.) et al. (22.141.092)- 1400 MHz radio sources
Samus' & Shugarov (26.154.026)- CMD to MS
Schneps et al. (22.154.029)- CO search
Strauss (22.154.011)- multi-color strip phot.

C2137-234 (NGC 7099, M 30)
Alcaino (22.154.004)- CMD
Alcaino & W.Liller (28.154.015)- CMD to MS
Seiradakis & D.Graham (27.141.537)- 21-cm search for periodicities
van Albada et al. (25.154.020)- ANS far-uv phot.
Welch & Code (27.154.018)- OAO energy distrib.
Williams & N.Bancall (26.154.006)- br.-, density- , and color-profiles

C2143-214 (Pal 12)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.
Cohen (J.) et al. (28.154.001)- cl. metal-rich via CO and heavy elt.
Harris & Canterna (26.154.005)- CMD to MS

C2304+124 (Pal 13)
Canterna & Schommer (21.154.005)- chem. abund.
Cowley et al. (21.114.010)- sp. of rG st.
Dickey & Malkan (27.154.016)- search for OH-em.

C2305-159 (NGC 7492)
Cowley et al. (21.114.010)- sp. of rG st.

C2346-732 (AM 3)
Madore & Arp (25.154.005)- discovery

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TABLE 5B - Information in Catalogs, Reviews, or Syntheses

Caputo (25.154.019)- CN abund.
Castellani et al. (28.065.061)- influence of st. rotation
Chun and Freeman (25.154.019)- radial inhomogenieties in 24 cl.
Clube and Watson (25.154.013)- cl. radial motions
Demarque & McClure (28.154.027)- MS fitting, He-abund.
Deupree et al. (21.154.022)- He-abund.
Enggenson (21.154.025)- cl. metallicity function
Gursky & Davis (28.142.080)- IUE cl. obs.
Harris & Canterna (25.154.027)- halo abund. gradient from 78 cl.
Harris & Racine (26.154.017)- cl. as subsystems of parent galaxies
Iwanowska (28.154.019)- CC and other basic data
Kadla (26.154.020)- relaxation times for cl.
Kraft (26.154.018)- non-homogeneity of cl. st.
Kukarkin & Kireeva (21.154.008)- blanketing effects in cl.
Kukarkin & Kireeva (25.154.013)- atlas of integr. mag. and struc. param.
Liller (W.) (21.142.235)- optical obs. of x-ray cl.
McClure (25.154.009)- I/S extinction and systemic flattening
Miyamoto et al. (28.154.020)- mass distrib. of MWG
Pagel (28.154.020)- metallicities and large-scale variations in MWG
Rastoguev & Surdin (28.154.045)- cl. orbital parameters
Ruprecht et al. (27.002.030)- Suppl.1 to 2nd Ed., Cat. of St. Cl. & Assoc.
Sasaki & Ishizawa (22.154.019)- cl. spatial distrib. in MWG
Searle & Zinn (22.154.018)- halo cl. CC, gal. halo formation
Sharov (22.154.040)- est. no. of MWG cl. is 500
van den Bergh (25.154.009)- I/S extinc. and systemic flattening
Zinn (27.154.019)- [m/H] and reddenings of 79 cl.
Zinn (28.154.021)- formation of cl. system

TABLE 5C - Clusters in Other Galactic Systems

Battistini et al. (28.154.164)- M 31 cl. search
Demers & Kunkel (21.154.023)- Reticulum cl. belongs to MWG
de Vaucouleurs (G.) & Buta (22.154.032)- cl. distrib. in MWG and M 31
de Vaucouleurs (G.) (28.154.010)- colors and sp. type for NGC 5128 cl.
Frogel (28.154.016)- IR phot. of NGC 5128 cl.
Frogel et al. (28.154.011)- IR phot. of 40 M 31 cl.
Graham (J.) and Phillips (28.158.077)- discovery of NGC 5128 cl.
Harris & Petrie (21.154.034)- cl. spatial distrib. around M 49
Karimova & Sharov (22.154.014)- M 31 cl. positions
Norris & Bessell (22.158.066)- anom. rG branches in Scl and UMi dwarf gal.
Racine, Oke & Searle (21.154.033)- M 87 cl. metallicities
Racine & Shara (26.154.022)- M 31 cl. luminosity distrib.
Sharov et al. (26.153.038)- pe phot. of Andromeda cl.
Sharov et al. (28.154.006)- pe UBV phot. of 18 cl. in M 31 and NGC 147

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## 7. Dynamics of Star Clusters

D. Heggie

Since the last thorough review of this topic in Reports on Astronomy (in 1976), about 200 relevant papers have appeared. It would be impossible to refer to every one of these, but fortunately they include some useful reviews. In addition to the reviews mentioned in Reports for 1979, we now have those by King and Heggie in the proceedings of I.A.U. Symposium No. 85, and King's George Darwin lecture (1). Even so, it seems worth summarising as many as possible of the recent researches, in order to bring these reviews up to date. In general, reference will be made to the most recent available work of each author or group, since authors rarely fail to refer to their own previous work!

At the most fundamental dynamical level, there has been substantial work on relaxation processes - the basic driving force behind much dynamical evolution. In addition to a little work on 'violent' relaxation (22.151.030, 28.151.055), work by Parisot and Severne (25.151.033) has considered how to develop the theory of collisional relaxation for inhomogeneous systems, and Kandrup has revived the debate about how to choose the cutoff at large impact parameters (2). There has been more work on the distribution of the velocity-changes experienced by stars in encounters (17.151.044, 25.151.032), and on other aspects of relaxation (19.151.023, 22.151.088). Theories of relaxation have been subjected to numerical checking (14.151.039, 19.151.018, 3), and the problem of relaxation among stars whose unperturbed motions are essentially periodic has recently been studied (4, 5, 6).

Another general theoretical problem is stability. Questions of dynamic stability continue to be studied (e.g. 22.151.055, 26.151.078, 28.151.003, 7), but most attention has been directed to thermodynamic instabilities under the general heading of the "gravothermal catastrophe", using various formalisms (e.g. 21.151.015, 27.151.018, 28.151.014, 28.151,082, 8). Consideration of the effects of a distribution of masses (17.151.041, 20.151.001, 22.151.008, 22.151.017, 9) has been one step in the direction of greater realism in such studies.

Important as such general theoretical problems are, a great deal of our most reliable information on the dynamical evolution of clusters comes from computer simulations. Here there have been significant advances including the introduction of new methods with some advantages for certain problems over existing techniques (20.151.047, 26.151.094). There have also been some useful developments in the hydrodynamic method (20.151.056, 27.151.015, 28.062.017), and the statistical reliability of the results of N-body calculations has also been tested (25.151.081).

Several fundamental features of the dynamical evolution of an N-body system can be understood in terms of relaxation and stability, but real systems are essentially more complicated than this idealised model. One of the most important additional processes, to which attention has been drawn recently, is loss of mass by stellar evolution. Though analytical results suggest that loss of half the mass may lead to complete disruption (27.151.004), numerical results show that the truth is not so simple (22.151.045, 26.153.029, 10). Furthermore, the importance of mass loss is largely restricted to the first few $10^9$ years in the lifetime of a globular cluster, and thereafter evolution proceeds much as it would in the absence of mass loss (27.151.055, 11). But mass-loss affects a greater fraction of the evolution of the shorter-lived open clusters (27.153.027). The hypothetical problem of cluster evolution with varying G has much in common with these problems (22.151.058).

One effect of mass loss in open star clusters is that they are not expected to exhibit any dramatic core collapse, since this involves the most massive stars and they evolve fastest. But the evolution of cores of globular clusters has received a great deal of attention, first, because there is no striking observational evidence for the core collapse that is expected on theoretical grounds, and, second, because of the discovery of variable X-ray sources near the centres of a few clusters. The clearest numerical results on core collapse in clusters with stars all of the same mass, though with an isotropic distribution of velocities, are by Cohn (28.151.088). This simplest problem has also attracted detailed theoretical attention (26.151.005, 26.151.035, 27.151.033).

As soon as more realistic problems of core evolution are considered, for example in multi-component systems (14.151.045, 21.151.022), either one must use simulations or else the theory has to be greatly simplified. Among the new phenomena that must be considered are dissipative processes (21.151.066, 22.151.009, 12), though most other aspects of dynamics of clusters can be understood on the point--mass approximation (21.151.047). One problem that has received much attention is the behaviour of the core in the presence of a black hole (18.066.016, 19.151.002, 20.066.028, 21.151.062, 22.151.093, 27.151.059, 27.151.066, 28.151.024, 28.151.119, 13). Incidentally, not all of even the most detailed numerical studies arrived at the same results on this problem, for reasons that have never been clarified.

The behaviour of binaries in star clusters, and their possible effects on the clusters themselves, have come under quite extensive study, and much of this has been reviewed recently (28.151.086). Among work not adequately referred to there, however, are some further studies of the effects of encounters between binaries and single stars (18.117.076, 28.151.035); some extensive work on the evolution of the distribution of binaries, and a wealth of other phenomena, by Retterer (27.151.029, 14); and several independent studies of the effect of binaries on the cluster itself (21.151.006, 21.151.046, 25.117.015, 27.153.045, 28.154.022). Binaries and other multiple systems may be one end product of the dissipation of open clusters (21.117.057, 21.117.058, 21.117.059, 15).

This brings us to one of the long-standing problems of the dynamics of star clusters - the theoretical calculation of the escape rate - and it has continued to receive attention (17.151.008, 18.151.001, 20.151.030, 21.151.012, 28.151.053). There is not yet any indication, however, that such theoretical studies are more reliable than simulations for predicting the effect of escape on the mass-distribution in clusters, but the process of escape is also of interest with regard to the shapes of globular clusters and also the formation of 'coronae' around clusters (18.151.042, 25.151.018). The reverse process - capture of stars by clusters - has also been considered (14.151.004).

In discussions of escape the role of the galactic tidal field is paramount. Keenan and Innanen have been studying extensively the tidal limiting radii, using very simplified models for the gravitational fields of the cluster and the Galaxy (26.042.009, 16). Other studies have been devoted to the tidal disruptive effects of a close passage by an interstellar cloud or a galactic nucleus (18.151.066, 20.151.042). Some of these problems reduce basically to a study of the orbits of stars in clusters, and there have been a few papers on this general topic (e.g. 18.151.058, 26.151.062, 28.021.043).

The ultimate aim of all these theoretical studies should be to put together the various dynamical processes which, for convenience, can be studied separately, in order to produce a detailed synthetic model in which no important process has been omitted, and which can be compared with observations. Even so, the construction of models having a simple analytical basis rather than a thorough dynamical basis has been pursued by several people (20.154.032, 25.151.059, 26.151.011, 26.151.067, 17). Therefore it is useful to have two studies (19.153.042, 20.151.034) showing the extent to which such simple models can and cannot be fitted to the results of simulations. Comparison with actual clusters is usually confined to the light distribution, and dynamical ages can even be assigned to open clusters in this way (17.151.010, 27.153.031), but now the comparison can be extended to include information on stellar velocities (22.151.109, 26.151.068, 28.154.039). The most ambitious comparison, using results from both dynamical simulations and stellar evolution, is that by Angeletti, Dolcetta and Giannone (18).

Finally, dynamical theory helps to account not just for the properties of individual clusters but also for properties of the system of clusters, such as its kinematics (14.153.019, 20.160.054, 28.154.008, 19) and the range of cluster masses, and other parameters (21.154.003, 28.151.087).

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## 8. Nomenclature

A. IAU NUMBERS FOR CLUSTERS

Resolution 1 taken by Commission 37 at the IAU General Assembly in Montreal, August 1979, was worded as follows:

Commission 37 recommends that the designation of star clusters within the Galaxy shall be based on the equatorial coordinates (1950.0) prefixed by the letter C. The right ascension element shall consist of hours and minutes of time (4 digits) and the declination element by algebraic sign followed by degrees and one decimal (3 digits); in both cases leading zeroes must be inserted where appropriate.

Once a designation has been assigned to a particular cluster it shall not be changed, even if later investigations indicate that the coordinates used in the designation differ from the centre of the cluster.

This resolution has been implemented during the past triennium by the following steps:

(1) The president has suggested a list of new numbers for already known clusters.
(2) The Stellar Data Centre in Strasbourg has accepted this list and taken the responsibility for maintaining and updating the nomenclature.
(3) Last and most important, cluster researchers have started to use the new numbers.

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E. NUMBERING OF STARS IN CLUSTERS

The problems of nomenclature of stars in general was discussed at Montreal by Commission 5, especially by a working group headed by W. Bidelman. Commission 37 participated in and supported those efforts. However, we also found it necessary to appoint a working group to deal with the problems of numbering stars in clusters where often much fainter stars are observed than those already catalogued. The working group has consisted of A. Moffat (chairman), G. Lyngå, J.-C. Mermilliod and S. van den Bergh. After consultation with the commission members the group has now made a proposal which may lead to a resolution at the IAU General Assembly in Patras. The proposed text is as follows:

(1) All star cluster investigators should always publish finding charts that unambiguously indicate the stars observed (preferably as in (2) below), if not given explicitely elsewhere. Even the measure of only a few stars justifies a chart. The chart should be labeled 'N' at the top for north and 'E' at the left for east with a line segment at the edge showing a simple number of arc units on the sky. Editors of appropriate journals should be urged to insist that authors comply.

(2) Numbering should be made in a systematic fashion. The preferred, most flexible way is to use XY coordinates in minutes or arc, centered on some arbitrary but precisely defined star or other position near the cluster centre and aligned so that X, Y are parallel to and go in the same sense as RA and Dec, respectively, for 1950.0. Once the origin has been chosen it must remain the same for all future work on a given cluster. An appropriate level of precision for the tabulated X, Y values should be adopted in order to avoid ambiguities. To facilitate easy use, the charts should indicate X, Y axes with tic marks at intervals of one arc minute or better, depending on the degree of concentration of the cluster. The scale should nominally be 1' per cm (6" per mm) or a simple multiple thereof. Once a good chart is published in this way for a given cluster, subsequent papers on the same cluster can, if appropriate, refer to it by X, Y coordinates for identification of stars, without having to make a new chart. Cross-identifications to old numbering systems should be supplied.

(3) A photographic atlas containing charts of all existing Galactic open and globular star clusters should be made by some central body (e.g. CDS) as a basis for (2). The charts would be left blank except for the addition of X, Y axes and tic marks. J.-C. Mermilliod has indicated he might supervise the undertaking of this task.

## 9. Some Trends in Cluster Research

The past triennium was for our commission opened by IAU Symposium No. 85 in Victoria, BC, Canada (27.012.007). All our three types of objects, associations, open clusters and globular clusters, were then discussed extensively. Naturally, much of the work during the following years has been inspired by this symposium.

A considerable improvement of the data situation for open as well as for globular clusters has taken place through the individual photometric and spectroscopic studies listed in the tables above. Particularly, we note that the number of spectral studies of member stars is increasing rapidly.

For open clusters large data contributions were given by Fenkart and Binggeli (25.153.008) and by Mermilliod (27.153.023). The catalogues described in section 3 above help to make existing data more widely known. The many photometric papers listed in table 4 have to a large extent aimed at determinations of ages and abundances. Discussions of age determinations have been made by Tosi (26.153.004) and by Mermilliod (1981a, 1981b). Turn-off points for a large number of open clusters have been determined by Janes and Adler (1982) who also relate the age distribution to the galactic structure. Other studies of the galactic gradient of cluster ages were made by Lyngå (27.155.024) and by van den Bergh and McClure

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(28.153.005). The dearth of old galactic clusters in the inner parts of the galactic disk seems established.

Abundance gradients in the galactic disk have been studied from the system of open clusters by Janes (25.155.021), by Panagia and Tosi (27.153.058) and by Lyngå (1982). A general decrease of metal abundance outwards in the galaxy is indicated. However, as Nissen (27.153.016) points out, large variations of helium as well as of heavier element abundances seem to exist over relatively short distances in the galactic disk. These circumstances should inspire many more photometric and spectroscopic investigations of open clusters.

The distance determinations of Hyades was reviewed by Hanson (27.153.017) on the basis of astrometric data. Nicolet (1982) has discussed distances of open clusters using the Geneva method of photometric boxes. Naturally, the galactic and extragalactic distance scales are very sensitive to such cluster studies. Radial velocities of open clusters are being re-discussed by Wramdemark (1982) in order to study large scale motions in the galactic disk.

When globular clusters were discussed during IAU Colloquium No. 68 in Schenectady, NY, USA there was a considerable increase of knowledge about abundances in globular cluster stars as compared to what was available two years earlier, at Victoria. In fact, 20 papers dealt with such investigations and some revision of the cluster abundance scale was made. Ages of globular clusters were also discussed in 1981 at Schenectady, now based on more detailed models of stellar evolution. Some reviewers pointed out that present knowledge admits the possibility that all globular clusters in our galaxy are coeval. More details and references to specific globular cluster investigations are found in sections 6 and 7 above.

The globular cluster systems in external galaxies have been reviewed several times (Racine and Harris, 26.154.017; van den Bergh, 27.154.027; Racine, 27.154.034). Clusters in the Magellanic Clouds, particularly the populous, blue clusters of LMC have been studied by many observers. The number of papers about Magellanic clusters was about 10 at the Victoria symposium and about 20 at the Schenectady colloquium. For detailed information about these studies we refer to the report of the working group on the Magellanic Clouds inside commission 28. Globular clusters have recently been found in NGC 5128 (Cen A) by Graham and Phillips (28.158.077); later discussions of clusters in NGC 5128 were made by Hesser, Harris, Harris and van den Bergh (1982). Open clusters in M31 were discussed by Hodge (25.158.200) and globular clusters in M31 by Fusi-Pecci (1982) and by Burstein, Faber, Gaskell and Krumm (1982). Again referring for more detail to the report of Commission 28 we note that the increasing availability of data for extragalactic cluster systems is a great help for understanding our own cluster systems.

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