

THE g AND p MODES OF POLYTROPES

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This is a supplement to a main article on the g and p modes of self-gravitating fluids (Sobouti 1977). In the latter, convective motions of an adiabatic fluid were identified with its neutral non-radial g oscillations. A definition of g modes followed from this limiting behaviour and a set of trial g displacements were developed. The latter were defined as those displacements of the fluid which left the pressure equilibrium of the fluid undisturbed. Next, the p modes were defined as those orthogonal to the g modes and the appropriate trial p displacements were obtained from the latter requirement. On using these developments and a Rayleigh-Ritz variational scheme, the eigenfrequencies and the eigendisplacements of polytropic structures are calculated. The numerical results are presented in the accompanying tables. A discussion of the tables, however, is to be found in sections VII and VIII of the main article which should be consulted for full details.

Key words: pulsation – convection

Legend to the Tables

Each table is specified by the values of the polytropic index, N , the ratio of specific heats, GAMMA , and the spherical harmonic number, L . In tables of $L=1$ and 2, both the eigenvalues (i.e. squares of the frequencies) and the eigenvectors (i.e. the set of the variational parameters of equations [8] and [9] of the main paper) are displayed. The g and p components of the vectors are explicitly marked and the largest component is assigned the unit value. In table of $L=3, 4, 5,$ and 6, only the eigenvalues are given. Each table contains computations from one to ten variational parameters with five parameters for each of the g and p modes in the most elaborate calculations. Eigenvalues are in units of $4\pi G\rho_c/(N+1)$, where ρ_c is the central density of the polytrope.

REFERENCE

Sobouti, Y.: 1977, *Astron. Astrophys.* (in press).

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Tables

EIGENVALUES ARE DISPLAYED IN LINES MARKED BY "*" AND P-COMPONENTS OF EIGENVECTORS ARE SO MARKED

Table 1 (Left): Data for N = 1.0, GAMMA = 5/3, L = 1. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Table 2 (Right): Data for N = 1.0, GAMMA = 5/2, L = 2. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

EIGENVALUES ARE DISPLAYED IN LINES MARKED BY "*" AND P-COMPONENTS OF EIGENVECTORS ARE SO MARKED

Table 3 (Left): Data for N = 1.5, GAMMA = 5/3, L = 1. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Table 4 (Right): Data for N = 1.5, GAMMA = 5/3, L = 2. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Eigenvalues are displayed in lines marked by "*" and columns following the eigenvalues are the eigenvalues. For the polytrope 1.5 the following

Table 5 (Left): Data for N = 1.5, GAMMA = 5/3, L = 1. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Table 6 (Right): Data for N = 1.5, GAMMA = 5/3, L = 2. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

quantities are identically zero and are suppressed. All eigenvalues, the g- components of the p- eigenvalues and the p- eigenvalue of the spherical harmonics l=1,

Table 7 (Left): Data for N = 1.5, GAMMA = 5/3, L = 1. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Table 8 (Right): Data for N = 1.5, GAMMA = 5/3, L = 2. Lists eigenvalues and p-components for various modes (e.g., P, G, S).

Tables (continued)

Table 1: Eigenvalues and components for G and P modes. Columns include mode number (e.g., G 1.000000E+01), eigenvalue, and component values. Includes a header for 'EIGENVALUES ARE DISPLAYED IN LINES MARKED BY ***'.

Table 2: Eigenvalues and components for G and P modes. Columns include mode number (e.g., G 1.000000E+01), eigenvalue, and component values. Includes a header for 'EIGENVALUES ARE DISPLAYED IN LINES MARKED BY ***'.

Table 3: Eigenvalues and components for G and P modes. Columns include mode number (e.g., G 1.000000E+01), eigenvalue, and component values. Includes a header for 'EIGENVALUES ARE DISPLAYED IN LINES MARKED BY ***'.

Table 4: Eigenvalues and components for G and P modes. Columns include mode number (e.g., G 1.000000E+01), eigenvalue, and component values. Includes a header for 'EIGENVALUES ARE DISPLAYED IN LINES MARKED BY ***'.

Tables (continued)

Table with columns for parameters (M, GAMMA, L) and lists of eigenvalues and eigenvectors. Includes sub-headers like 'EIGENVALUES ARE DISPLAYED IN LINES MARKED BY ***'.

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Tables (continued)

Table 1: Eigenvalues and eigenvectors for G and P components for Gamma = 5/3, L = 1. The table is organized into columns G1 through G4 and P1 through P4. Eigenvalues are shown in lines marked with asterisks, and eigenvectors are in lines marked with crosses. The G and P components are also indicated for each set of vectors.

Table 2: Eigenvalues and eigenvectors for G and P components for Gamma = 5/2, L = 2. Similar to Table 1, it lists eigenvalues and eigenvectors for G and P components across columns G1-G4 and P1-P4.

Table 3: Squares of the non-radial oscillation frequencies for polytropes with Gamma = 1.0 and L = 3. The table shows frequencies for modes G1-G4 and P1-P4.

Table 4: Squares of the non-radial oscillation frequencies for polytropes with Gamma = 5/3 and L = 3. Similar to Table 3, it shows frequencies for modes G1-G4 and P1-P4.

Tables (continued)

THE SQUARES OF THE NON-RADIAL OSCILLATION FREQUENCIES OF POLYTROPES

N = 3.5 GAMMA = 5/3

L = 3

1039011E+00
173232E+00 342548E+00
966327E+00 173256E+00 342573E+00
820915E+00 167949E+00 242529E+00
375842E+00 199460E+00 166802E+00 820750E+00
737636E+00 193445E+00 168028E+00 231885E+00 437929E+00
448985E+00 191152E+00 168349E+00 231841E+00 409331E+00
174330E+00 185891E+00 167743E+00 231824E+00 408785E+00 24584E+01
259124E+00 185234E+00 167774E+00 231824E+00 408802E+00 24589E+01
299133E+00 185235E+00 167774E+00 231824E+00 408802E+00 24589E+01
185235E+00 167774E+00 231824E+00 408802E+00 24589E+01

L = 4

197548E+00
185302E+00 359723E+00
996822E+00 193206E+00 359724E+00
194112E+00 192101E+00 359495E+00 872290E+00
442979E+00 192211E+00 359438E+00 872516E+00
417759E+00 192022E+00 359278E+00 872024E+00 161130E+01
711973E+00 186241E+00 117877E+00 247524E+00 555317E+00 161130E+01
211714E+00 186231E+00 117874E+00 247524E+00 555317E+00 258733E+01
38552E+00 186231E+00 117874E+00 247524E+00 555317E+00 258733E+01
186231E+00 117874E+00 247524E+00 555317E+00 258733E+01

L = 5

193761E+00
182301E+00 386230E+00
359731E+00 199918E+00 386383E+00
491037E+00 199800E+00 386790E+00 887212E+00
442374E+00 112794E+00 207964E+00 268242E+00 888881E+00
448867E+00 112794E+00 207964E+00 268242E+00 888881E+00
741726E+00 108638E+00 182917E+00 268242E+00 888881E+00
26427E+00 182917E+00 268242E+00 888881E+00
146524E+00 182917E+00 268242E+00 888881E+00

L = 5

168338E+00
176699E+00 358910E+00
305448E+00 198694E+00 359481E+00
105478E+00 195512E+00 358162E+00 896651E+00
456577E+00 185327E+00 208758E+00 282498E+00 16594E+01
48734E+00 185327E+00 208758E+00 282498E+00 16594E+01
96624E+00 185327E+00 208758E+00 282498E+00 16594E+01
76427E+00 185327E+00 208758E+00 282498E+00 16594E+01
79484E+00 185327E+00 208758E+00 282498E+00 16594E+01
79427E+00 185327E+00 208758E+00 282498E+00 16594E+01

N = 3.5 GAMMA = 5/3

L = 3

228325E+00
192612E+00 269438E+00
184451E+00 202798E+00 270268E+00
793193E+00 184623E+00 226107E+00
319102E+00 184623E+00 226107E+00
191914E+00 184623E+00 226107E+00 269356E+00 929176E+00
126581E+00 184623E+00 226107E+00 269356E+00 929176E+00
129166E+00 184623E+00 226107E+00 269356E+00 929176E+00
107451E+00 184623E+00 226107E+00 269356E+00 929176E+00

L = 4

231637E+00
187924E+00 252185E+00
262455E+00 198744E+00 252185E+00
793722E+00 185011E+00 236520E+00 503935E+00
729668E+00 185011E+00 236520E+00 503935E+00
329589E+00 185011E+00 236520E+00 503935E+00 900210E+00
147685E+00 185011E+00 236520E+00 503935E+00 900210E+00
147685E+00 185011E+00 236520E+00 503935E+00 900210E+00
202020E+00 185011E+00 236520E+00 503935E+00 900210E+00
79348E+00 185011E+00 236520E+00 503935E+00 900210E+00

L = 5

209500E+00
175904E+00 223629E+00
516211E+00 181223E+00 240955E+00
737394E+00 181223E+00 240955E+00 446811E+00
312493E+00 181223E+00 240955E+00 446811E+00
112477E+00 181223E+00 240955E+00 446811E+00 847403E+00
185367E+00 181223E+00 240955E+00 446811E+00 847403E+00
156764E+00 181223E+00 240955E+00 446811E+00 847403E+00
79497E+00 181223E+00 240955E+00 446811E+00 847403E+00
234513E+00 181223E+00 240955E+00 446811E+00 847403E+00

L = 6

174692E+00
153716E+00 194452E+00
644433E+00 174440E+00 214452E+00
549815E+00 153722E+00 202343E+00 436320E+00
721047E+00 153722E+00 202343E+00 436320E+00
300345E+00 153722E+00 202343E+00 436320E+00 800594E+00
164277E+00 153722E+00 202343E+00 436320E+00 800594E+00
16702E+00 153722E+00 202343E+00 436320E+00 800594E+00
244015E+00 153722E+00 202343E+00 436320E+00 800594E+00
74765E+00 153722E+00 202343E+00 436320E+00 800594E+00

G4 G2 G1 G2 G1 G2 G3 G4

THE SQUARES OF THE NON-RADIAL OSCILLATION FREQUENCIES OF POLYTROPES

N = 4.5 GAMMA = 5/3

L = 3

266421E+00
138537E+00 271555E+00
187678E+00 149121E+00 279585E+00
379463E+00 119446E+00 282796E+00 316954E+00
196874E+00 132784E+00 131078E+00 248464E+00 316173E+00
195681E+00 144169E+00 176499E+00 183591E+00 268354E+00
830778E+00 28145E+00 145404E+00 859722E+00 144297E+00 248464E+00
174717E+00 279603E+00 147661E+00 718112E+00 134423E+00 176831E+00
131441E+00 132527E+00 147767E+00 172438E+00 132567E+00 176831E+00
116789E+00 137867E+00 147718E+00 167126E+00 136655E+00 176831E+00

L = 4

253703E+00
943856E+00 254483E+00
724647E+00 107360E+00 273118E+00
364404E+00 887922E+00 207322E+00 245814E+00
174719E+00 144732E+00 130876E+00 217332E+00 248180E+00
174678E+00 140564E+00 176384E+00 117847E+00 278597E+00 396747E+00
65474E+00 265848E+00 123770E+00 815647E+00 123770E+00 277958E+00
654259E+00 26473E+00 1415634E+00 131128E+00 138834E+00 68456E+00
105787E+00 32627E+00 145630E+00 693249E+00 123249E+00 159974E+00
105248E+00 32627E+00 145630E+00 693249E+00 123249E+00 159974E+00

L = 5

264509E+00
708840E+00 204827E+00
511122E+00 177349E+00 236499E+00
318137E+00 142735E+00 166348E+00 243942E+00
191160E+00 147284E+00 792593E+00 173462E+00 248498E+00
152378E+00 191681E+00 686745E+00 324324E+00 247454E+00
65976E+00 276499E+00 140189E+00 78747E+00 100882E+00 268321E+00
65817E+00 27639E+00 139398E+00 78099E+00 94332E+00 144630E+00
105444E+00 188499E+00 141296E+00 781856E+00 189867E+00 144742E+00
104409E+00 189314E+00 141296E+00 689333E+00 189593E+00 115185E+00

L = 5

145295E+00
680221E+00 145335E+00
364332E+00 631163E+00 184994E+00
327131E+00 478694E+00 140839E+00 198094E+00
132641E+00 402078E+00 87924E+00 147325E+00 214335E+00
132641E+00 393859E+00 568568E+00 83847E+00 203848E+00
66254E+00 20651E+00 140035E+00 714416E+00 894992E+00 27736E+00
65414E+00 206370E+00 399232E+00 708362E+00 756357E+00 140679E+00
10787E+00 27732E+00 486834E+00 732139E+00 88932E+00 140791E+00
10723E+00 27746E+00 486834E+00 732139E+00 88932E+00 140791E+00

G4 G2 G1 G2 G1 G2 G3 G4