SHORT COMMUNICATIONS

IDENTIFICATION OF RADIO SOURCES BETWEEN DECLINATIONS −20° AND −30°*

By J. G. Bolton† and Jennifer Ekers†

Bolton, Clarke, and Ekers (1965) have recently suggested some 55 identifications for radio sources between declinations −20° and −44° from inspection of the Palomar Sky Survey plates in positions of radio sources in the Parkes catalogue for declinations −20° to −60° (Bolton, Gardner, and Mackey 1964). As the estimated accuracy of the catalogue positions was $\sim 0 \cdot 6$ min of arc in both coordinates, identifications were suggested only for objects brighter than $\sim 17 \cdot 5$ magnitude in order to avoid chance coincidences.

More precise positions for 54 of the sources between declinations −20° and −33° have now been determined by Shimmins, Clarke, and Ekers (unpublished data). The improved accuracy of these positions reduces the search area to less than one-tenth of that of the catalogue positions and permits identification with objects as faint as $\sim 19 \cdot 5$ magnitude. Thirteen new identifications are suggested from a re-examination of the Sky Survey prints in the 54 positions. Seven of these are faint galaxies and five are quasi-stellar objects; the other (1420−27) may either be a quasi-stellar object with some associated nebulosity, or alternatively a very blue galaxy.

Data on the new identifications are given in Table 1. The positions of the optical counterparts were estimated from the Sky Survey prints with the aid of transparent overlays containing the position of the source and positions of at least six stars from the Yale Catalogue. The positions are given to 0·5 sec in right ascension and 0·1 min of arc in declination, though the uncertainty in measurement could be twice as large. The agreement between the measured optical positions and the radio positions determined by Shimmins, Clarke, and Ekers is better than 0·8 sec in right ascension and 0·3 min of arc in declination. Flux densities and spectral indices for the sources are taken from the Parkes catalogue. Abbreviations in column 6 of Table 1 are: E, elliptical; D, spherical galaxy with diffuse envelope; g, galaxy too faint for classification; and QSO?, possible quasi-stellar object. Photographic magnitudes for the galaxies and visual magnitudes for the quasi-stellar objects were estimated from the Sky Survey prints; for such faint objects, however, the estimates may be in error by as much as one magnitude.

Finding charts for the new identifications are given in Plates 1 and 2. For the galaxies, the charts were prepared from the Sky Survey "E" or red prints and, for the quasi-stellar objects, from the "O" or blue prints.

* Manuscript received December 22, 1965.

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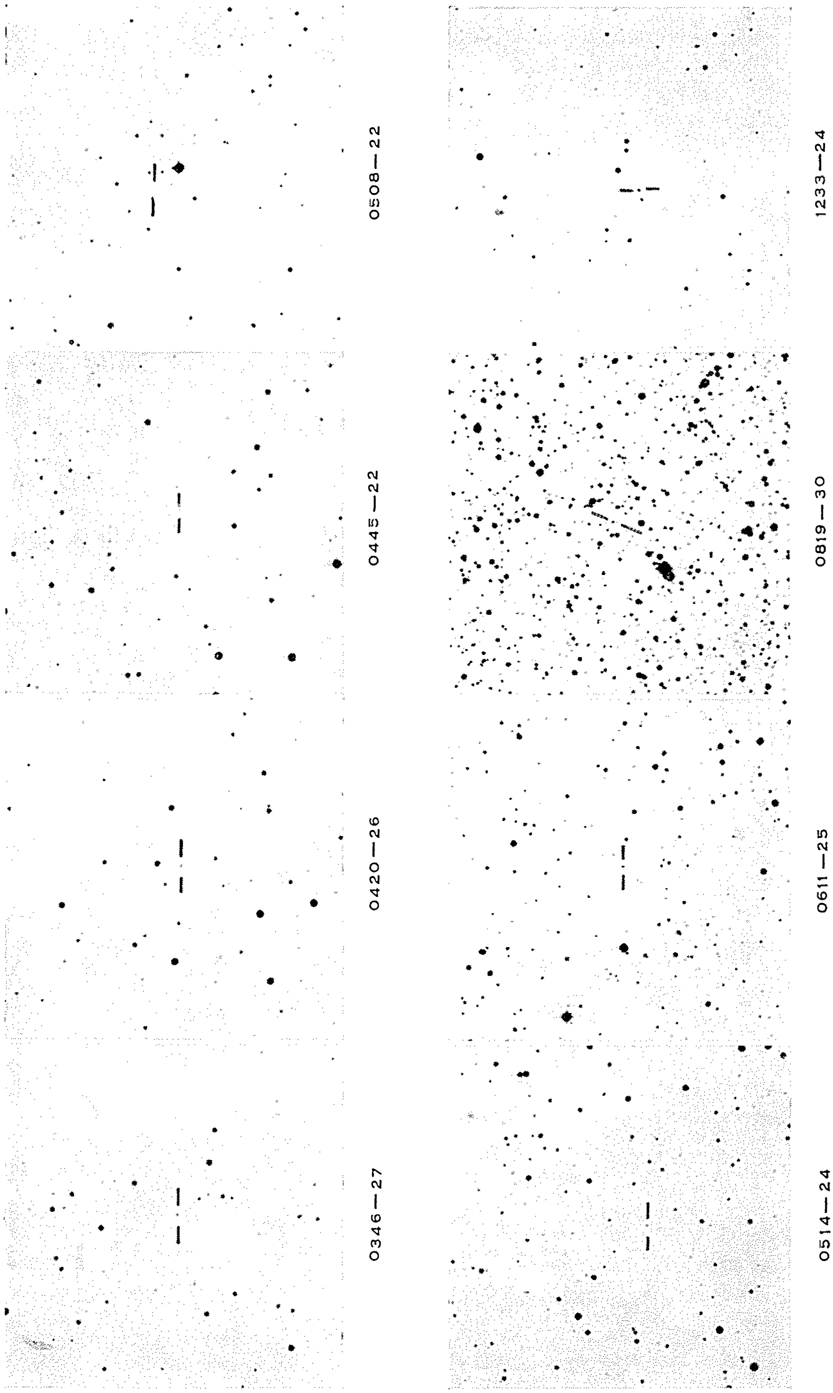
TABLE 1

LIST OF IDENTIFICATIONS

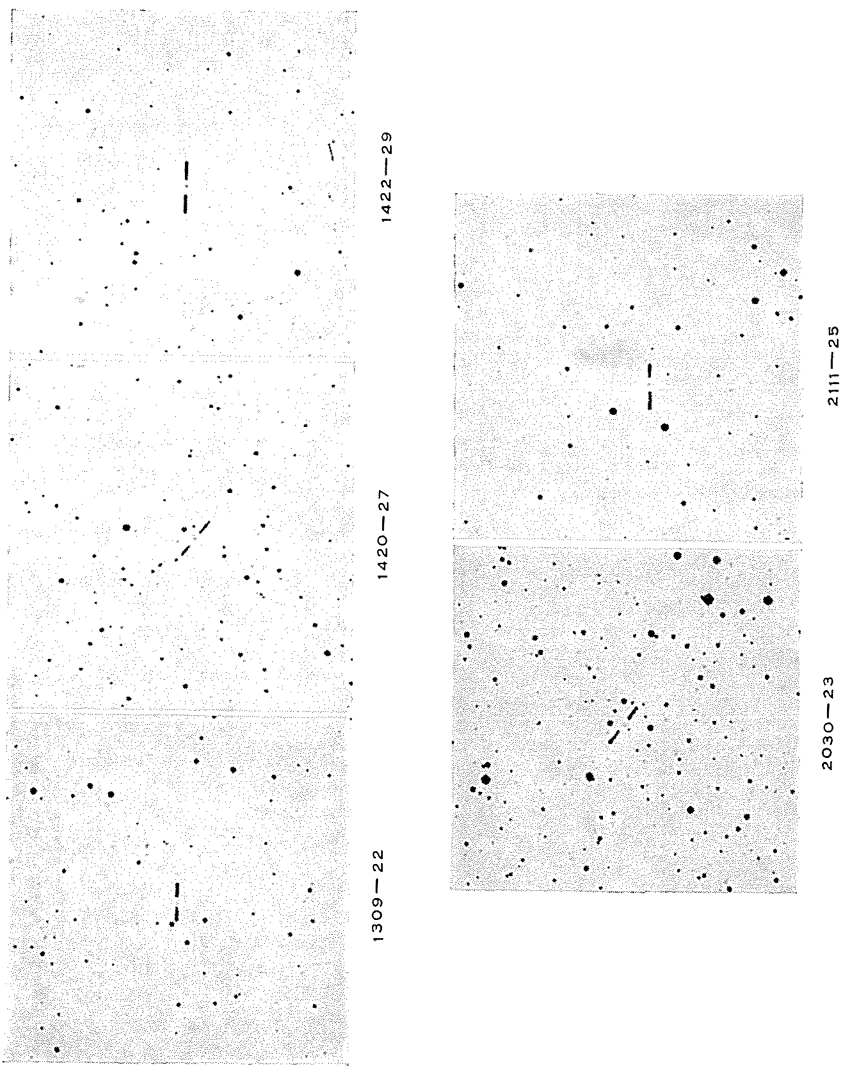
Catalogue Number	Position (1950) R.A. h m s	Position (1950) Dec. ° ′	Flux Density at 1410 Mc/s (10^{-26} W $m^{-2}(c/s)^{-1}$)	Spectral Index	Type	Photographic Magnitude	Galactic Coordinates l^{II}	Galactic Coordinates b^{II}	Remarks	Alternate Cat. Nos.
0346−27	03 46 33·0	−27 59·0	1·4	−0·1	E3	19	224	−51		03−*210*
0420−26	04 20 30·0	−26 23·5	1·4	−0·8	E	18·5	224	−43		04−*26*
0445−22	04 45 29·0	−22 08·7	2·0		g	20	221	−36	Curved spectrum	
0508−22	05 08 53·5	−22 05·0	1·9	−0·8	QSO?	18·5	223	−32		05−*23*
0541−24	05 41 09·5	−24 22·7	1·5	−0·9	QSO?	18·5	228	−25		05−*27*
0611−25	06 11 31·5	−25 29·8	1·1	−0·8	E	18·5	233	−19		
0819−30	08 19 25·5	−30 01·4	3·0	−0·7	E3	18·2	250	4	In obscured region, probably brighter	08−*23*
1233−24	12 32 59·5	−24 55·7	2·3	−0·9	QSO?	17	299	38		12−*27*
1309−22	13 08 58·0	−22 00·9	5·4	−1·2	g	20	309	40	Wyndham (1965) reports no identification for this source. His declination, however, is 30″ north of position determined by Shimmins, Clarke, and Ekers	13−*23*, 3C 283
1420−27	14 19 55·0	−27 14·3	2·6	−1·0	QSO?	18	327	31	Sky Survey red print suggests some nebulosity surrounding this object. It may be a very blue galaxy	14−*28*
1422−29	14 22 32·5	−29 46·8	2·5	−0·9	QSO?	17·5	326	29		14−*210*
2030−23	20 30 20·0	−23 03·4	3·0	−0·8	D	20	22	−32	Neither the accuracy of radio position nor of measurement of optical position from Sky Survey print permits separation of suggested galaxy from star immediately south following. The latter, however, appears to be of normal colour	20−*28*
2111−25	21 11 44·5	−25 54·4	2·6		QSO?	19	22	−42	Curved spectrum	

RADIO SOURCES BETWEEN -20° AND -30°



Finding charts for identified objects 0346−27 to 1233−24. Scale is 5 mm = 1 min of arc. North-east is at the top left-hand corner of each chart.

RADIO SOURCES BETWEEN −20° AND −30°



Finding charts for identified objects 1309—22 to 2111—25. Scale is 5 mm = 1 min of arc. North-east is at the top left-hand corner of each chart.

References

Bolton, J. G., Clarke, Margaret E., and Ekers, R. D. (1955).—*Aust. J. Phys.* **18**: 627.
Bolton, J. G., Gardner, F. F., and Mackey, M. B. (1964).—*Aust. J. Phys.* **17**: 340.
Wyndham, J. D. (1965).—*Astr. J.* **70**: 384.

THEORETICAL DISPERSION OF SURFACE WAVES FOR SOME CRUSTAL MODELS*

By L. THOMAS†

Dispersion curves of seismic surface waves, showing phase velocities as functions of period for both Rayleigh waves and Love waves, can be determined experimentally (e.g. Brune, Nafe, and Oliver 1960), and can also be calculated theoretically for given models of the crust (Haskell 1953; Bolt and Butcher 1960). Such models may be tested and perhaps refined by comparing theoretical with observed dispersion curves for a particular region.

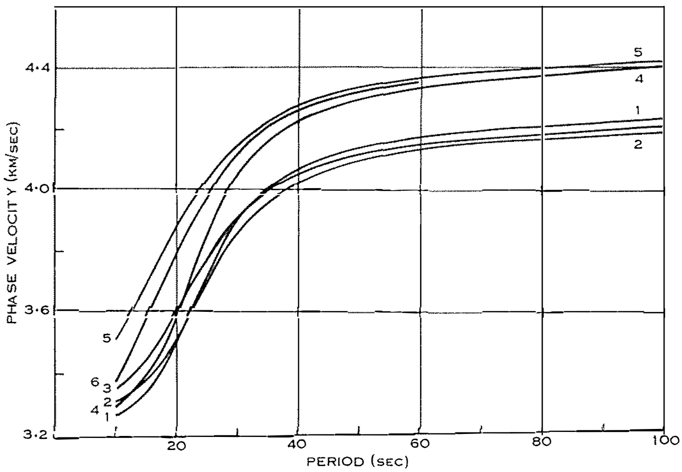


Fig. 1.—Rayleigh wave velocities for models 1–6.

To provide the theoretical curves of phase velocity as a function of period (the dispersion curves) for both Rayleigh and Love waves, computer programs have been written for the C.D.C. 3600 computer of the CSIRO in Canberra. The computer programs have been written in the form of "function subroutines" and are available from the program library of the Computing Research Section, CSIRO. One program (VELLR) calculates the velocity of a Rayleigh wave of given period, and the other (VELLQ) calculates the Love wave velocity.

The matrix method of Haskell (1953) is used in each case to calculate the phase velocity of the surface wave at a given period. The Earth models used may consist of up to 24 layers of homogeneous perfectly elastic media in welded contact with each other, overlying a similar medium of infinite depth. The properties of each layer are fixed by specifying the density, thickness, and compressional and shear velocities in that layer. The velocity value obtained is correct to four significant figures.

* Manuscript received January 5, 1966.

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The VELLR subroutine returns a velocity value to the main program in about $0 \cdot 5(L - 1\frac{1}{3})$ sec, where L is the number of layers in the model, and VELLQ returns its value in about $0 \cdot 15(L - 1\frac{1}{8})$ sec. The times increase slightly as the period increases.

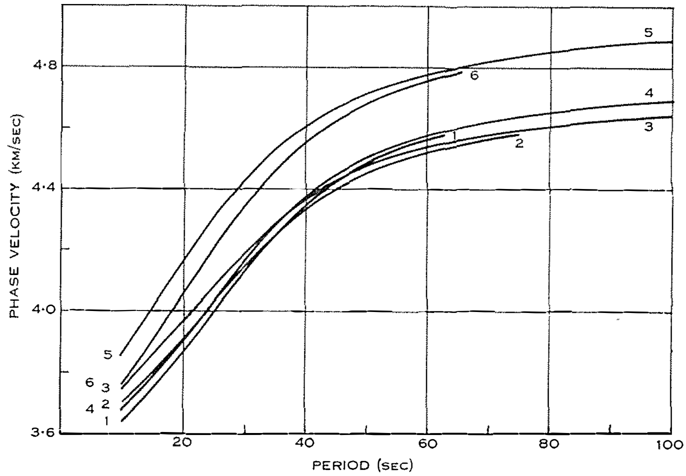

Fig. 2.—Love wave velocities for models 1–6.

TABLE 1

COMPARISON OF THE CRUSTAL MODELS

Properties of the Layers*	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
ρ_1	2·65	2·67	2·6	2·75	2·75	2·75
d_1	36	37	20	3	3	3
α_1	6·03	6·03	6·03	5·9	5·9	5·9
β_1	3·55	3·61	3·61	3·5	3·5	3·5
ρ_2	3·4	3·33	2·7	2·75	2·75	2·75
d_2			20	32	11	17
α_2	8·21	8·16	6·5	6·18	6·18	6·18
β_2	4·75	4·7	3·85	3·59	3·59	3·59
ρ_3			3·33	3·5	3·05	3·05
d_3					28	22
α_3			8·16	8·48	7·24	7·24
β_3			4·7	4·95	4·15	4·15
ρ_4					3·5	3·5
α_4					8·48	8·48
β_4					4·95	4·95

* ρ = density of layer (g/cm^3), d = thickness of layer (km), α = velocity of compressional wave in layer (km/sec), and β = velocity of shear wave in layer (km/sec).

By minor changes to the programs, more than 24 layers may be accommodated, or greater or less accuracy may be obtained.

Computations were carried out for a number of models relevant to the Australian continent and the results are shown in Figures 1 and 2. The models are described in Table 1. Model 1 is based on the results of Bolt, Doyle, and Sutton (1958). Models 2 and 3 were suggested by Underwood (personal communication) and models 4, 5, and 6 by Everingham (personal communication).

The density values for model 1 were chosen somewhat arbitrarily, and several different combinations were computed. These results were used to calculate curves of $\partial c/\partial w$ (where c is the phase velocity and $w = \rho_1/\rho_2$, ρ_1 being the density of layer 1,

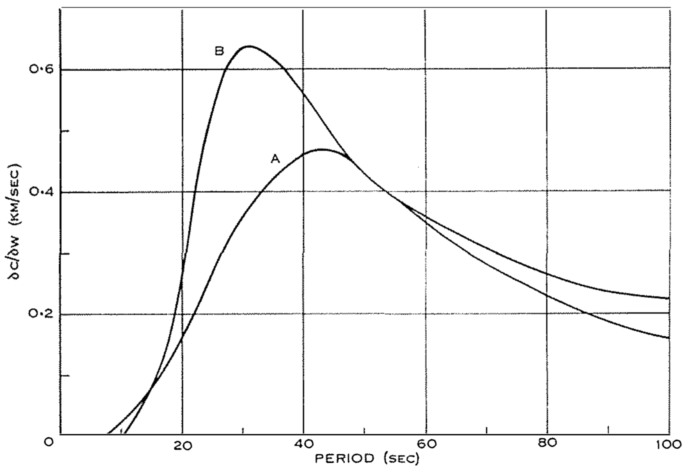

Fig. 3.—Curves of $\partial c/\partial w$ at various periods for (A) Love and (B) Rayleigh waves.

ρ_2 the density of layer 2) at various periods for both Love and Rayleigh waves. These curves are shown in Figure 3, and illustrate one way in which the computer subroutine might be used to improve Earth models.

With the increase, in recent years, of the number of long-period seismographs in Australia, and the use of computing facilities as described above, the study of surface wave dispersion can be expected to produce important information about the crust of the Australian continent.

References

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Haskell, N. A. (1953).—*Bull. Seism. Soc. Am.* **43**: 17.