The range upto 400*G* can be taken to consist mainly of Mn stars, the range 400 to 700*G* being a mixture of Mn and Cr–Sr stars, with the Mn stars showing a preference for lower values and the others for higher values. The range beyond 700*G* seems to be the domain of Cr–Sr stars.

With the help of these groupings, the abundance peculiarities of those magnetic stars about which these details are not known, can perhaps be estimated. Thus the six stars in the range below 250*G*, whose peculiarities are not known, could mostly be Mn stars, or perhaps Am stars. Likewise, the two stars of unknown peculiarity in the range 600 to 700*G* are more likely to be Cr–Sr stars than Mn stars. And the three stars with unknown peculiarities in the range beyond 1000*G* should in all probability be Cr–Sr stars. Some of these stars could well be non-peculiar with measurable fields, a point which a re-examination of their spectra alone can ascertain.

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G. S. D. Babu, S. D. Sinvhal
Uttar Pradesh State Observatory
Manora Peak
Naini Tal
India

MOLECULES IN ETA AQUILAE

M. C. Pande, G. C. Joshi, B. M. Tripathi, V. P. Gaur, Uttar Pradesh State Observatory, Naini Tal, India

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The total numbers I_Φ(AB) of a given molecule AB in a column extending between $\tau = 0$ to $\tau = 3{\cdot}00$ have been calculated for various phases Φ of light variations in η Aql for the molecules CO, CN, C_2, OH, NH and CH. At all phases, the log I_Φ(AB) values decrease in the order CO, OH, CH, NH, CN and C_2.

Consideration of log I_Φ(AB) — Φ curves shows that the amplitude of the curves, the extent of the hump at $\Phi = 0{\cdot}15$, the slopes of the ascending and descending branches and the phase interval [between the instants on two sides of the minimum phase, at which log I_Φ(AB) is less by 0·5 than the value of log I_Φ(AB) at the minimum phase] decrease in the order of decreasing dissociation energy of the molecule, i.e., CO, CN, C_2, OH, NH and CH.

It is found that higher dissociation energy molecules form in higher layers at all phases and that for all the molecules considered, the average geometrical depth of formation progressively shifts towards deeper layers as one proceeds from maximum phase to minimum phase of light variation in the star. Finally the dissociation equilibrium abundances of molecular species closely follow the shape of the light curve including its asymmetry and hump and that the abundances of higher dissociation energy molecules reflect this correspondence better.

Молекулы в η *Aql.* Вычислены полные числа I_Φ(AB) данной молекулы AB в столбце, заключенном между $\tau = 0$ и $\tau = 3{,}00$ для разных фаз изменения блеска η Aql для молекул CO, CN, C_2, OH, NH и CH. Для всех фаз значения log I_Φ(AB) уменьшаются в следующем порядке: CO, OH, CH, NH, CN и C_2.

Рассмотрение кривых log I_Φ(AB) — Φ показывает, что все величины в скобках (амплитуды кривых, величина горба при $\Phi = 0{,}15$, градиенты восходящих и нисходящих ветвей, а также интервал фазы между моментами, по обеих сторонах от минимума, при которых log I_Φ(AB) меньше на 0,5, чем значение в минимуме) уменьшаются с уменьшением энергии диссоциации молекулы, а именно в следующем порядке: CO, CN, C_2, OH, NH и CH.

Найдено, что молекулы с высокой энергией диссоциации при всех фазах образуются в высоких слоях

и что средняя геометрическая глубина образования систематически смещается к более глубоким слоям от фазы максимума до фазы минимума изменения блеска звезды.
Наконец получено, что при диссоциационном равновесии содержания молекул хорошо соответствуют форме кривой блеска включая ее ассиметрию и наличие горба, а также, что содержания молекул с высокой энергией диссоциации лучше отражают это соответствие.

1. *Introduction*

The light curves of cepheids are generally asymmetric and show humps on either ascending or descending branches. The star δ Cep studied earlier by us (Pande et al., 1971) has a light curve which is asymmetric but has no hump on either of the branches, while η Aql has an asymmetric light curve with a hump between phases $\Phi = 0{\cdot}1$ to $0{\cdot}4$ (cf. Nicolov, 1968). Further, in contrast with δ Cep for which model atmospheres exist only for two phases, model atmospheres at eight phases of light variation, viz. $\Phi = 0{\cdot}0$ (max); ($0{\cdot}15$, $0{\cdot}90$); ($0{\cdot}35$, $0{\cdot}85$), ($0{\cdot}556$, $0{\cdot}75$) and $0{\cdot}68$ (min), exist for η Aql (Dawe, 1968); the five values of the respective effective temperatures T_e and the effective gravity g_e being: (6500 K; $2{\cdot}5$ cm sec^{-2}), (6040 K; $2{\cdot}2$ cm sec^{-2}); (5820 K; $2{\cdot}0$ cm sec^{-2}), (5470 K; $1{\cdot}50$ cm sec^{-2}) and (5330 K; $1{\cdot}0$ cm sec^{-2}). This star then appears to be well suited for investigating the correspondence of the dissociation equilibrium abundances of CO, CN, C_2, OH, NH and CH with the peculiarities of the light curve of η Aql. The present investigation reports the results of such calculations.

2. *Dissociation equilibrium calculations*

Following the procedure outlined in Pande et al. (1969) the concentration-optical depth curves for each of the eight phases, for which the model atmospheres are available, were obtained. On performing the necessary integrations between the limits $\tau = 0$ to $\tau = 3{\cdot}00$, these curves yielded the quantity I_Φ(AB), i.e., the total number per cm^2 of a given molecule AB, and $\bar{Z}$(AB) the mean geometrical depth of formation in each model atmosphere. Solar abundances and and LTE are assumed to prevail. The molecules considered are CO, CN, C_2, NH, OH and CH.

In Fig. 1, the quantities $\log I_\Phi$(AB) for the above six molecules and the magnitude of η Aql. in U colour (Nicolov, 1968) are plotted against the phase Φ of the light variation in η Aql. In Fig. 2 and Fig. 3 $\log I_\Phi$(AB) and $\bar{Z}$(AB), respectively, are plotted against D(AB), the dissociation energy of the molecule AB for various phases.

The curves $\log I_\Phi$(AB) $-$ Φ in Fig. 1 were used to obtain the following additional parameters:

(1) The amplitude of variation α(AB) of $\log I_\Phi$(AB), which is the difference of $\log I_\Phi$(AB) values at minimum and maximum phases.

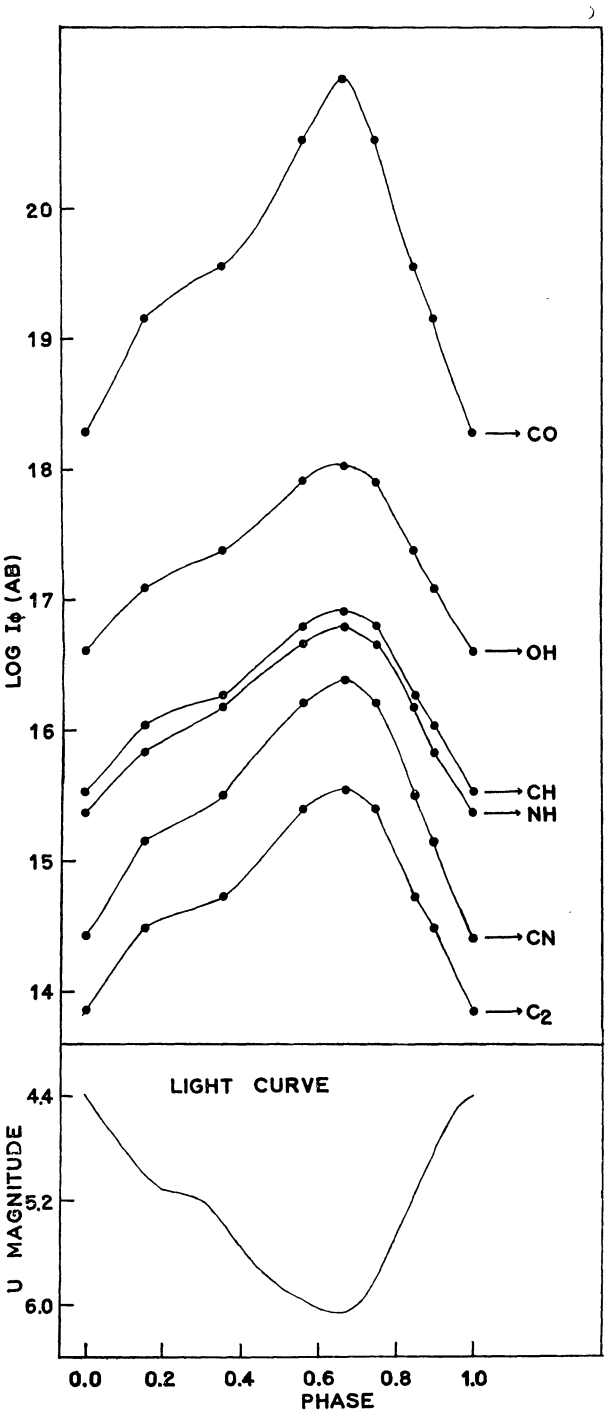

Fig. 1. The variation of $\log I_\Phi$(AB) over a cycle of light variation of η Aql for molecules CO, OH, CH, NH, CN and C_2. The U light curve is also shown.

(2) The magnitude of the hump in the abundance curves of Fig. 1, at phase $\Phi = 0{\cdot}15$, denoted as $\beta(\mathrm{AB})$. To obtain this quantity we first estimated $I^*_\Phi(\mathrm{AB})$, the value of $\log I_\Phi(\mathrm{AB})$ at $\Phi = 0{\cdot}15$, on the assumption that between $\Phi = 0$ and $0{\cdot}35$ the $\log I_\Phi(\mathrm{AB}) - \Phi$ curve can be represented by a straight line if the hump is ignored. We then put $\beta(\mathrm{AB}) = I_\Phi(\mathrm{AB}) - I^*_\Phi(\mathrm{AB})$ for $\Phi = 0{\cdot}15$. The quantities $\alpha(\mathrm{AB})$ and $\beta(\mathrm{AB})$ are plotted against $D(\mathrm{AB})$ in Fig. 4.

(3) The slopes S_1 and S_2 of the curves in Fig. 1, defined as $S_1 = \alpha(\mathrm{AB})/0{\cdot}68$ and $S_2 = \alpha(\mathrm{AB})/0{\cdot}32$, respectively, are plotted in Fig. 5. S_1 and S_2 correspond to the descending and ascending branches of the light curve of η Aql.

(4) The phase span $\Delta\Phi(\mathrm{AB}) = \Phi_1(\mathrm{AB}) - \Phi_2(\mathrm{AB})$, where $\Phi_1(\mathrm{AB})$ and $\Phi_2(\mathrm{AB})$ are two phases on two sides of the minimum phase at which the $\log I_\Phi(\mathrm{AB})$ value drops down by $0{\cdot}50$ as compared to the $\log I_\Phi(\mathrm{AB})$ value at minimum phase ($\Phi = 0{\cdot}68$). The quantity $\Delta\Phi(\mathrm{AB})$ is plotted against $D(\mathrm{AB})$ in Fig. 5.

Finally, all the results are tabulated in Table 1.

3. *Discussions*

1. As for δ Cep (Pande et al., 1971), we find that for all phases of the light curve of η Aql the molecular abundances are in the order CO, OH, CH, NH, CN and C_2 (cf. Fig. 1). At any phase the $\bar{Z}(\mathrm{AB})$ values decrease in the order CH, NH, OH, C_2, CN and CO, i.e., the higher dissociation energy molecules form in the higher layers of the star. In consonance with this,

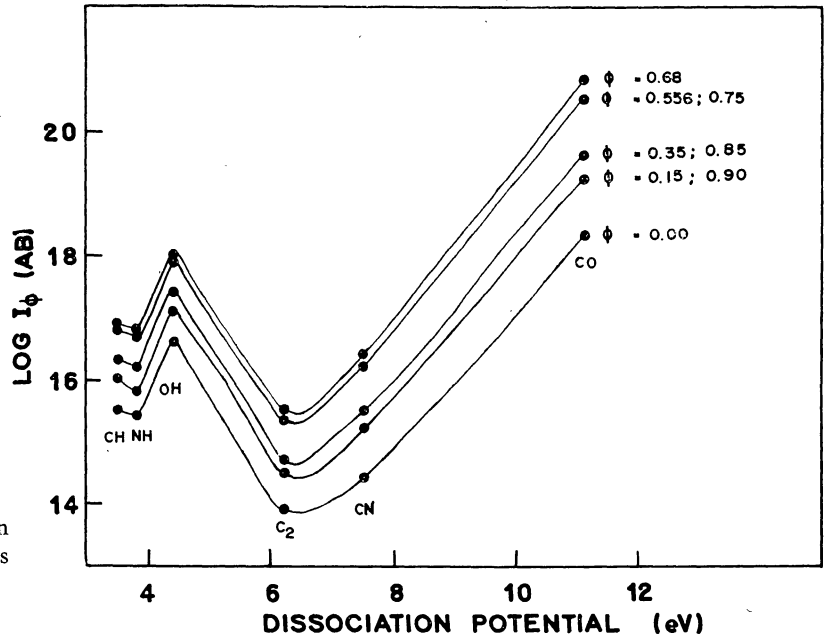

Fig. 2. The dependence of $\log I_\Phi(\mathrm{AB})$ on the dissociation potential for various phases of a cycle of light variation of η Aql.

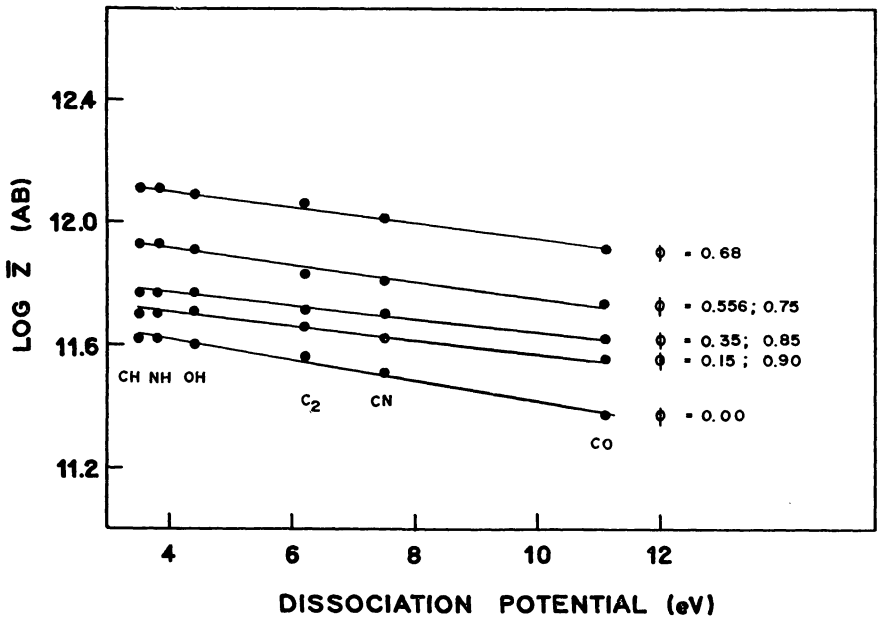

Fig. 3. The dependence of average geometrical depth of formation $\bar{Z}(\mathrm{AB})$ for molecules CO, CN, C_2, OH, NH and CH on the dissociation potential for different phases.

Table 1

Results of dissociation equilibrium calculation for a complete light variation cycle of η Aquilae

Molecule	CO	CN	C_2	OH	NH	CH
Dissociation energy in e. v.	11·10	7·50	6·21	4·40	3·76	3·47
Φ	log I_Φ(AB)					
0·0 (Max)	18·29	14·42	13·85	16·61	15·37	15·53
0·15 and 0·90	19·16	15·15	14·49	17·09	15·83	16·04
0·35 and 0·85	19·56	15·50	14·73	17·38	16·18	16·27
0·556 and 0·75	20·53	16·21	15·40	17·91	16·66	16·80
0·68 (Min)	20·80	16·39	15·54	18·03	16·79	16·91
Φ	log $\bar{Z}$(AB) in km					
0·0 (Max)	11·47	11·51	11·56	11·60	11·62	11·62
0·15 and 0·90	11·55	11·62	11·66	11·71	11·70	11·70
0·35 and 0·85	11·62	11·70	11·71	11·77	11·77	11·77
0·556 and 0·75	11·73	11·81	11·83	11·91	11·93	11·93
0·68 (Min)	11·91	12·02	12·06	12·09	12·10	12·11
	Other parameters					
α(AB)	2·51	1·97	1·69	1·42	1·42	1·38
β(AB)	0·33	0·27	0·26	0·16	0·12	0·19
S_1(AB)	3·69	2·90	2·49	2·09	2·09	2·03
S_2(AB)	7·84	7·16	5·28	4·44	4·44	4·31
$\Delta\Phi$(AB)	0·27	0·32	0·33	0·40	0·44	0·44

for all molecules the $\bar{Z}$(AB) values progressively increase as one proceeds from maximum to minimum phases of the light variation (cf. Fig. 3). The amplitude of the variation of log I_Φ(AB), i.e., α(AB), decreases with decreasing D(AB) in the order CO, CN, C_2, OH, NH and CH (cf. Fig. 4).

2. The log I_Φ(AB) – D(AB) curves of Fig. 2 suggest that we are dealing with a situation similar to that found in our investigation of the dissociation equilibrium of the six molecules mentioned in Stankiewicz's sunspot models (cf. Gaur et al., 1971, Fig. 1). The explanation given therein ascribing the decrease of log I_Φ(AB) in the order CO, CN and C_2 to pure temperature effect and the increase in log I_Φ(AB) of OH, NH and CH as the effect of large partial pressure of hydrogen, therefore, seems to be valid in this case also.

3. The behaviour of the β(AB) – D(AB) curves suggests that the higher dissociation energy molecules, like CO, are more sensitive to the presence of humps in the light curves of the cepheids than lower dissociation energy molecules, like CH. Another fact, noticeable in the β(AB) – D(AB) curve, is that β(AB) monotonically decreases in the order CO, CN, C_2, OH and NH, but then increases for CH. This may be due to the fact that temperature variations in the models of η Aql during hump may be inappreciable and the effect of large partial pressures of hydrogen on the hydrogen containing molecules may be reflected in case of CH.

4. We see that Fig. 5 shows $S_2 > S_1$ for each of the six molecules considered. As S_2 corresponds to the ascending branch of the light curve, we expected larger values of S_2 than those of S_1 if a correspondence between the dissociation equilibrium molecular abundances and the light curve really exists. Both S_2 and S_1 decrease with decreasing dissociation energy of the molecule which means that the higher dissociation energy molecules are more sensitive to the changes in the physical conditions of the η Aql atmosphere during a cycle of light variation.

5. Figure 5 shows that higher dissociation energy molecules have a smaller $\Delta\Phi$ than the lower dissociation energy molecules.

6. Conclusions 3 and 4 mean that the higher dissociation energy molecules suffer a relatively more rapid variation in log I_Φ(AB) than the lower dissociation energy molecules over a cycle of light variation of η Aql.

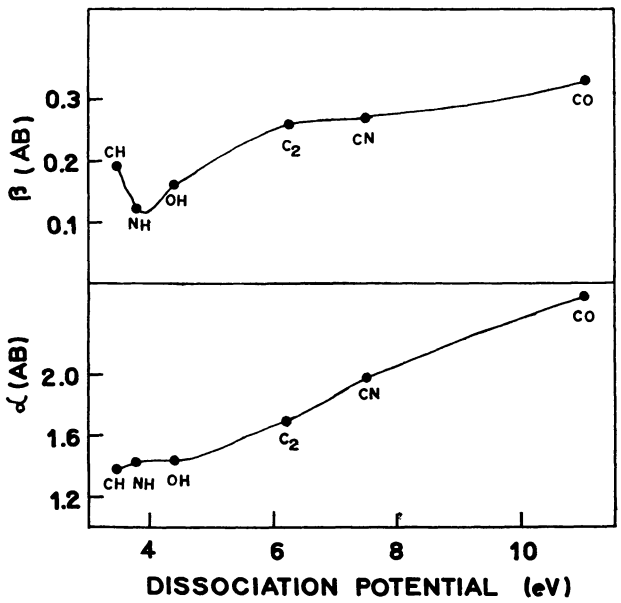

Fig. 4. The upper curve shows the dependence of the extent of the hump (cf. text) at phase $\Phi = 0{\cdot}15$ on the dissociation energy of the considered molecules.
Lower curve shows the dependence of α, the logarithmic amplitude of the variation of I_Φ(AB) for η Aql on the dissociation potential of the considered molecules.

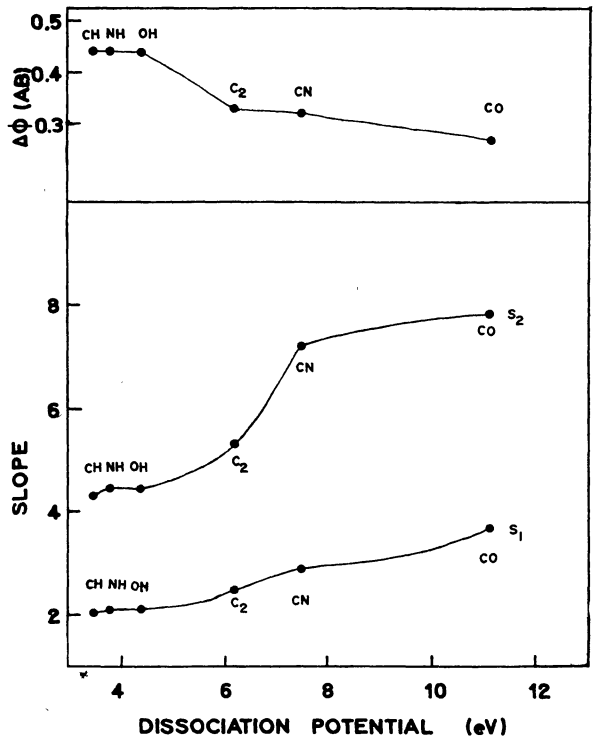

Fig. 5.
Upper curve: Ordinate $\Delta\Phi$(AB) represents the phase span $\Phi_1 - \Phi_2$ around the minimum where Φ_1 and Φ_2 correspond to two instants at which the log I_Φ(AB) value drops down by 0·5 over the value at minimum.
Lower curve: Ordinate represents $S_1 = \alpha/0{\cdot}68$ and $S_2 = \alpha/0{\cdot}32$ where α is the logarithmic amplitude of the I_Φ(AB) curves (cf. Fig. 4, lower curve). Abscissa in both cases is the dissociation potential in eV.

Summing up, we conclude that the molecular abundances vary in fairly good correspondence with the form of the light curve, and higher dissociation energy molecules are more sensitive to the effective temperature changes during the cycle of light variation and to the presence of such features as humps in the light curves of cepheids. Thus, a study of the lines of these molecules over a complete cycle of light variation of a given cepheid will allow one to know about the variations in the temperature structure of its atmosphere during the pulsation. The higher dissociation energy molecules CO, CN and C_2 will give the information about the changes in the physical conditions in the higher layers, while the lower dissociation energy molecules like OH, NH and CH give the same information about relatively deeper layers.

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M. C. Pande, G. C. Joshi, B. M. Tripathi, V. P. Gaur
Uttar Pradesh State Observatory
Manora Peak
Naini Tal
India

BOOK REVIEWS

НОВЫЕ КАЧЕСТВЕННЫЕ МЕТОДЫ В НЕБЕСНОЙ МЕХАНИКЕ

(New Qualitative Methods in Celestial Mechanics) by E. A. Grebenikov and Yu. A. Ryabov

Publishing House Nauka, Moskva 1971; 442 pages; price 2·02 Rbl, in Russian.

The reviewed book deals with the differential equations of motion of celestial mechanics in two basic — mutually independent — directions. In the first part, the methods of averaging are studied, and the second part is concerned with the quasi-periodic solutions.

As has been said, Part I of the book is devoted (up to p. 177) to the problem of averaging of the differential equations of celestial mechanics. Chapter I of this part represents a mathematical exposition of the methods of averaging; the corresponding theorems, and proofs where required, for various types of the ordinary differential equations are given. In Chapter II, as well as in Chapter III, the authors specify the methods expounded on the problems of celestial mechanics. Eventually, in Chapter IV the methods of averaging are applied to the analytic theories of the motion of asteroids in cases of resonance, the cases of non-resonance being briefly included in the final part of this Chapter.

In Part II, the authors are interested in the existence and construction of the quasi-periodic solutions of the differential

equations of motion of celestial mechanics. Concretely, in the canonical systems with the Hamiltonian $H = H_0(p) + H_1(p, q)$. In the first seven chapters, the case when $\det(\partial^2 H_0/\partial p_i\, \partial p_j) \neq 0$, $i, j = 1, 2, \ldots, n$, is studied. Chapter VII gives the proof of the existence of the quasi-periodic solutions of the canonical system for this case. In the subsequent chapters (the ninth and the tenth) the case when H_0 does not depend on the all n variables p_j, $j = 1, 2, \ldots, n$, i.e. $H_0 = H_0(p_1, \ldots, p_{n_0})$, $n_0 < n (\Rightarrow \det(\partial^2 H_0/\partial p_i\, \partial p_j) = 0)$, is taken into account. Chapter XI deals with the quasi-periodic solutions in the neighbourhood of the equilibrium points of the elliptic type, which is directly applicable to the equilateral triangle libration points of the circular restricted three-body problem. Chapter XII considers another alternative of the case of degeneration. In Chapter XIII the obtained results are specified on the restricted three-body problem. Finally, Chapter XIV is concerned with the study of the quasi-periodic solutions of the non-canonical systems.

The merit of the book is the summarization of material, hitherto scattered, from both areas exammined in Part I and II into one publication, which will make it easier to orientate in the given field not only for students, but also for specialists. For this reason I am convinced that the book will be very popular with them.

V. Matas

СПРАВОЧНОЕ РУКОВОДСТВО ПО НЕБЕСНОЙ МЕХАНИКЕ И АСТРОДИНАМИКЕ

(Handbook of Celestial Mechanics and Astrodynamics)

Edited by G. N. Duboshin; Publishing House Nauka, Moskva 1971; pp. 584, Price 2·62 Rbl; in Russian.

A team of authors (V. K. Abalakin, E. P. Aksenov, E. A. Grebenikov, Yu. A. Ryabov) wrote a useful Handbook of Celestial Mechanics and Astrodynamics. At the moment such books are very necessary, because the number of scientific publications in this field is rapidly increasing, miscellaneous methods are used, and therefore, the initial relations are no longer matter-of-fact even for specialists from fields which differ only little. The second reason why a handbook of this kind is to be welcomed is that even the foremost specialists require this type of publication for quick orientation in their everyday work. This objective was met very well by the authors and their distribution of the topics was very generous. It is the reviewer's opinion that it is particularly convenient that the formulas are frequently given in several co-ordinate systems, that a system of astronomical constants has been organically built in to the celestial mechanics, that the authors not only deal with traditional celestial mechanics of mass points, but also with the celestial mechanics of bodies, that numerical and qualitative metods are given, etc.

The book is not written (as many handbooks are) in the form of ready-made formulas. Where possible the authors mention how the conclusion was reached. However, on the other hand, they avoid tedious proofs, which make most monographies impractical for quick orientation, and refer the reader to literature.

The extent of the problems is very wide; it may perhaps be best illustrated by giving a few headings at random: Principal Formulae of Spherical Astronomy, System of Astronomical Constants, The Two-body Problem, Methods of Orbit Determination, The n-body Problem, Developments of the Perturbative Function, Spherical Functions, Lunar Theory, The Three-body Problem, Trajectories of Artificial Celestial Bodies, Numerical Methods, Dynamics of Celestial Bodies with Variable Mass, Qualitative Methods in Celestial Mechanics, etc.

It is hard to find more serious defficiencies in such a good book. Perhaps some of the method of computing perturbations would call for more space (e.g., Gauss' method). From the point of view of foreign readers it would be convenient if the references pertaining to papers translated into Russian were also quoted in their original. To conclude it can be said that the reviewed book is a very useful handbook. It will be welcomed not only by specialists, but also by students and all who have a deeper interest in celestial mechanics and astrodynamics.

P. Andrle

ERRATA

to the paper

THE DENSITY WAVE MODEL OF THE INNER PARTS OF THE GALAXY

(*B. Basu, A. K. Roy*, 1972, Bull. Astron. Inst. Czech. 23, 117)

The post address of B. Basu (p. 123) was erroneously written. 75/3a Hazra Road should be instead of 57/3a Hazra Road.