We have above a very simple example of a general principle, viz. that in order that a partial differential equation of the second order, or a pair of simultaneous partial differential equations of the first order, may admit of a solution containing arbitrary functions, the coefficients must satisfy a certain equation of condition; from which it follows that, except in the simplest instances (in which the terms of the equation of condition vanish), there is a moral certainty that such a differential equation or pair of equations which have not been specially selected for the purpose, *and whose coefficients do not involve a disposable quantity by which the equation of condition may be satisfied,* will not admit of a solution involving arbitrary functions.

The equations applicable to the motion of an elastic fluid along the axis of a tube afford a remarkable illustration of the scope of these remarks.

Those equations consist of a pair of partial differential equations of the first order involving *five* variables, viz. y, t, ρ, v, p; and it may be shown *à priori*, that when derived upon a true theory they must be capable of a solution containing *two* arbitrary functions; from which it follows that a *third* equation will require to be satisfied. For this purpose we have p, the pressure, ready to our hands.

From the fact of the existence of the equation of condition not having been suspected by the founders of the theory of fluid-motion, at the same time that it was absolutely necessary for them to assign a form to p, they had recourse for that purpose to an empirical method; thus, on the one hand, depriving us of the power of satisfying the requirements of the problem, and on the other, abandoning the means for the determination of p which the analysis furnishes.

It cannot be matter of surprise that the law of pressure suggested under these circumstances should be entirely erroneous, as (by two other independent methods, one founded upon purely physical, the other upon purely analytical considerations) I have elsewhere shown.

III. "On the Lunar Atmospheric Tide at Melbourne." By Dr. G. Neumayer, late Director of the Flagstaff Observatory, Mem. Acad. Leop. Communicated by Lieut.-Gen. Sabine, President. Received April 10, 1867.

Anxious to assist the development of so interesting a branch of knowledge on the connexion of forces in nature as the influence our satellite exerts upon the earth's atmosphere, I had made it a point to include investigations, tending to facilitate studies in this direction, in the plan of discussion of the observations made at the Flagstaff Observatory about to be published. Fully aware that a geographical position, such as that of Melbourne (37° 48′ 45″ south lat. and 9^h 39^m 53^s east long.), affords but very few chances for arriving forthwith at a result which might be regarded as final, I thought it nevertheless of the highest importance to decide how

far and to what an extent such small oscillations as those in question, and which for lower latitudes have already been proved to exist, would make themselves manifest, in spite of the great atmospheric disturbances of higher latitudes. The volume of discussions above referred to contains consequently the results of the reduction and classification of upwards of 43,500 hourly observations on pressure of air, registered during the period from the 1st of March 1858 to the 28th of February 1863; and in publishing these results I was chiefly guided by the conviction that it would hardly be compatible with the scope of such a work to enter upon a full discussion of the phenomena connected with the lunar influence on the barometer; while a complete reduction and classification would make the observations apt to be taken up by any one interested in this matter for the purpose of being subjected to a rigorous examination and discussion. While engaged upon this task, I could not fail, however, to be struck by some very interesting facts which, though they are far from being reducible to definite laws, may serve to furnish some connecting links with respect to atmospheric tides, and to give evidence as to the possibility of proving their existence even in as high a latitude as that of Melbourne. A successful attempt at a complete solution of the problem may only be hoped for when a larger number of discussions on barometrical observations, collected at ectropical stations, will be at our command.

Prior to entering upon the task proposed, it appears desirable to give a few particulars, requisite for a full understanding of the subjoined results. The geographical position of the Flagstaff Observatory was already mentioned, and it remains only to be added that the standard barometer was one of Newman's construction, 0·400 inch in diameter, its cistern being 120·7 feet above the mean level of the sea. A few facts respecting the oceanic tides gleaned from 'the Sailing Directions for Port Phillip,' by Capt. Ferguson (1861), may also find a place here.

High water at full and change.			Vertical rise and fall.	
	h	m	Spring. ft.	Neap. ft.
On the beach at Pt. Lonsdale	11	25	7	4
In the midchannel between Pt. Lonsdale and Pt. Nepean	1	50		
At the Lightship, West channel	2	10	4	3
At the East end of South channel	2	25	4	3
At the Bird rock, Geelong	2	30	3·5	2·5
At Pt. Gellibrand and mouth of River Yarra	3	0	4·5	2·5

There is no necessity for entering more fully into a description of the method employed in freeing the barometrical observations from the regular diurnal fluctuation and arranging the remainders $b-\bar{b}$ according to lunar time, inasmuch as this method is quite identical with the one employed by all who have directed their attention to this subject, as General Sabine,

Professor Kreil, and others. This much may be stated, however, that the reading of the barometer (b), after being reduced to 32°, was invariably increased by 1 inch, in order that it may always exceed the mean pressure for the respective hour ($\bar{b}$), thereby avoiding negative results. This has certainly the disadvantage of not exhibiting at a glance the excess or defect of atmospheric pressure at any time; on the other hand, there is no doubt that a mistake with regard to the algebraic sign of the remainders is not likely to occur. In the subsequent Tables it was made a rule to reduce the values $b-\bar{b}$ to their mean value for a month, year, or whatever other period of time they may refer to.

The remainders $b-\bar{b}$ were derived, in the manner just pointed out, for every month throughout the period of five years for which the observations were continued. Then the means for every month and hour were taken, thus obtaining normal values for the several months; a general mean for every month formed the basis to which those normal values were referred. The subjoined Table shows the result of this proceeding.

The values of the above Table have been thrown into curves, and Plate I. shows the results. The actual mean values are indicated by dots; a full-drawn curve is made to pass through and between them in such a manner as to eliminate the greater irregularities. Some of those irregularities are so large as to cause the respective dots to be disconnected with the series to which they belong, and it became therefore necessary to indicate this connexion by slight dotted lines.

On glancing over this series of curves we cannot fail to observe a great regularity, pointing at some cause common to all; and as the remainders $b-\bar{b}$ have been arranged according to the moon's hour-angle, we may justly look to the moon as the primary cause. But it is nevertheless true that those curves apparently point to some other influence, most likely due to the combined action of the sun and moon. The monthly curves for the several years of observation have also been drawn, though we refrain from adding the results here; and the fact that they correspond in the main points with those shown on Plate I., seems to justify our attaching particular weight to the evidence of the moon's influence on our atmosphere, as conveyed to our minds by the above Tables. But prior to entering fully upon the various points bearing on the question at issue, we need to form of the monthly results quarterly and semiannual groups. If we call March, April, May the first, June, July, August the second, September, October, November the third, and December, January, February the fourth quarter, we obtain the quarterly means inserted in the following Table. It was furthermore considered serviceable to the purpose to group together those quarters in which the epochs of solstices and equinoxes respectively occur, under the collective names "solstitial and equinoctial quarters." The semiannual periods comprise, as usually, the months from April to September, and those from October to March. The mean of all the various hourly values represents the mean lunar-diurnal variation in pressure of air for the year.

1st part.—From the superior to the inferior passage. (1858–63).

Months.	0h.	1h	2h.	3h.	4h.	5h.	6h.	7h.	8h.	9h.	10h.	11h.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
April	+0·00210	−0·00290	−0·00150	−0·00264	−0·00018	+0·00130	+0·00030	+0·00124	+0·00152	−0·00092	+0·00076	+0·00036
May	+0·00085	+0·00673	−0·00115	+0·00233	−0·00051	−0·00221	+0·00219	+0·00031	−0·00377	−0·00011	+0·00551	+0·00097
June	+0·00508	+0·00168	−0·00052	−0·00296	−0·00432	−0·00808	−0·00592	−0·00812	−0·00696	−0·00376	−0·00264	+0·00224
July	+0·00218	−0·00320	−0·00536	−0·00590	−0·00412	−0·00168	+0·00036	+0·00170	+0·00522	+0·00718	+0·00724	−0·00014
August ...	+0·00713	+0·00437	−0·00203	−0·00097	+0·00225	+0·00353	+0·00137	+0·00035	−0·00141	−0·00347	−0·00371	−0·00277
September	+0·00474	+0·00214	+0·00020	+0·00138	+0·00498	+0·00552	−0·00152	+0·00002	+0·00042	−0·00342	+0·00050	−0·00230
October ...	−0·00403	−0·00025	−0·00497	−0·00595	−0·00251	−0·00047	+0·00169	+0·00117	+0·00303	−0·00059	+0·00139	+0·00265
November	−0·00676	−0·00612	−0·00210	+0·00144	−0·00406	+0·00098	+0·00282	−0·00028	+0·00380	+0·00728	+0·00176	+0·00706
December	+0·00377	+0·00257	+0·00457	+0·00201	+0·00381	+0·00131	+0·00251	−0·00453	−0·00207	−0·01083	+0·00049	+0·00321
January	−0·00178	−0·00568	−0·00310	−0·00068	+0·00158	+0·00324	−0·00226	+0·00016	+0·00162	−0·00644	−0·00328	+0·00152
February	−0·00465	+0·00073	−0·00005	+0·00045	+0·00193	−0·00033	−0·00145	−0·00227	−0·00225	+0·00057	−0·00375	−0·00253
March ...	−0·00402	−0·00430	−0·00290	+0·00024	+0·00124	+0·00156	+0·00516	+0·00966	+0·00724	+0·00536	−0·00108	−0·00082

2nd part.—From the inferior to the superior passage. (1858–63.)

Months.	12h.	13h.	14h.	15h.	16h.	17h.	18h.	19h.	20h.	21h.	22h.	23h.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
April	+0·00162	+0·00106	+0·00138	+0·00230	+0·00094	+0·00252	+0·00096	−0·00082	−0·00340	−0·00296	−0·00444	+0·00130
May	−0·00033	+0·00357	+0·00311	+0·00001	−0·00329	−0·00331	−0·00443	−0·00281	−0·00441	−0·00767	−0·00103	+0·00939
June	+0·00136	+0·00222	+0·00782	−0·00112	+0·00248	−0·00102	+0·00218	+0·00168	+0·00164	+0·00136	+0·00732	+0·00844
July	−0·00072	−0·00364	−0·00134	+0·00104	+0·00018	−0·00044	−0·00162	−0·00300	−0·00278	+0·00074	+0·00522	+0·00284
August ...	−0·00205	−0·00371	−0·00209	+0·00009	−0·00137	−0·00161	−0·00377	+0·00129	+0·00509	+0·00383	−0·00063	+0·00035
September	+0·00008	+0·00058	+0·00190	−0·00012	+0·00092	+0·00008	−0·00284	−0·00782	−0·00502	−0·00290	−0·00290	+0·00540
October ...	−0·00179	−0·00081	+0·00243	+0·00181	+0·00177	−0·00063	+0·00249	−0·00007	−0·00127	+0·01033	+0·00057	−0·00603
November	+0·00720	+0·00412	+0·00284	+0·00068	+0·00500	+0·00250	−0·00340	−0·00140	−0·00288	−0·00910	−0·01032	−0·01012
December	−0·00013	−0·00453	−0·01007	−0·00705	−0·00401	−0·00341	+0·00143	+0·00289	−0·00109	−0·00029	+0·00897	+0·01143
January ...	+0·00082	+0·00399	+0·00440	+0·00240	+0·00176	−0·00408	−0·00136	+0·00242	+0·00358	−0·00392	+0·00116	+0·00394
February	−0·00411	−0·00417	−0·00227	−0·00001	+0·00275	+0·00363	+0·00473	+0·00473	+0·00245	+0·00265	+0·00225	+0·00097
March......	−0·00226	+0·00016	+0·00086	−0·00038	−0·00326	−0·00060	+0·00014	−0·00332	−0·00292	+0·00028	−0·00214	−0·00388

1st part. From the superior to the inferior passage.

(1858–63.)

	0^h.	1^h.	2^h.	3^h.	4^h.	5^h.	6^h.	7^h.	8^h.	9^h.	10^h.	11^h.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
I. Quarter	−0·000355	−0·000155	−0·001848	−0·000021	+0·000185	+0·000219	+0·002552	+0·003739	+0·001665	+0·001445	+0·001732	+0·000172
II. "	+0·004724	+0·000952	−0·002635	−0·003275	−0·002061	−0·002075	−0·001395	−0·002021	−0·001048	−0·000015	+0·000298	+0·000221
III. "	−0·002017	−0·001410	−0·002290	−0·001043	−0·000530	+0·002010	+0·000997	+0·000303	+0·002417	+0·001090	+0·004217	+0·002470
IV. "	−0·000870	−0·000810	+0·000456	+0·000576	+0·002423	+0·001436	−0·000417	−0·002234	−0·000917	−0·005584	−0·002524	+0·000716
Equinoc. } quarters.	−0·001226	−0·000066	−0·002100	−0·000563	−0·000205	+0·001084	+0·001744	+0·001990	+0·002010	+0·001237	+0·002944	+0·001290
Solstitial } quarters.	+0·001927	+0·000071	−0·001089	−0·001349	+0·000181	−0·000319	−0·000906	−0·002127	−0·000982	−0·002799	−0·001112	+0·000248
Apr. to Sept	+0·003680	+0·001470	−0·001727	−0·001460	−0·000317	−0·000270	−0·000537	−0·000750	−0·000830	−0·000750	+0·001277	−0·000273
Oct. to Mar.	−0·002911	−0·002174	−0·001424	−0·000414	+0·000332	+0·001049	+0·001412	+0·000652	+0·001896	−0·000774	+0·000592	+0·001849
Year	+0·000391	−0·000346	−0·001569	−0·000931	+0·000014	+0·000396	+0·000444	−0·000042	+0·000539	−0·000756	+0·000941	+0·000795

2nd part. From the inferior to the superior passage.

(1858–63.)

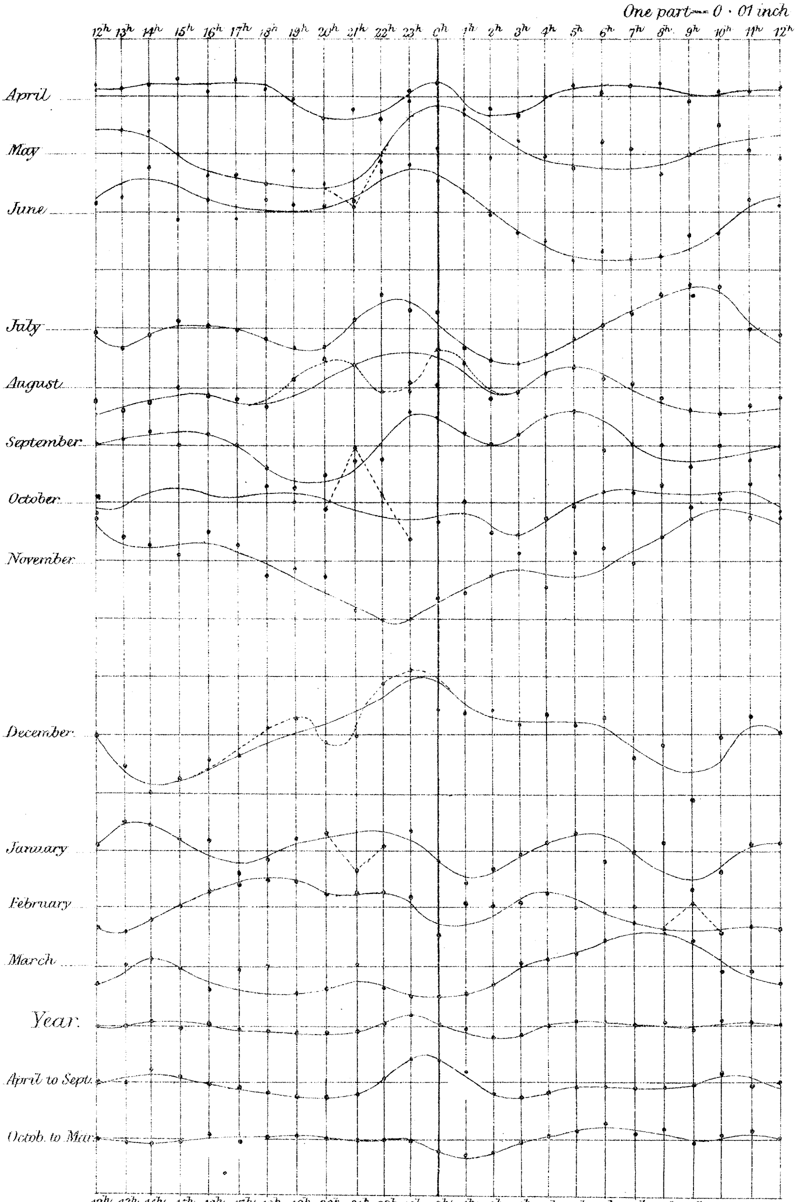
	12^h.	13^h.	14^h.	15^h.	16^h.	17^h.	18^h.	19^h.	20^h.	21^h.	22^h.	23^h.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
I. Quarter	−0·000322	+0·001599	+0·001785	+0·000645	−0·001868	−0·000461	−0·001108	−0·002315	−0·003575	−0·003448	−0·002535	+0·002272
II. "	−0·000468	−0·001708	+0·001465	+0·000005	+0·000432	−0·001021	−0·001068	−0·000008	+0·001318	+0·001979	+0·003972	+0·003879
III. "	+0·001830	+0·001297	+0·002390	+0·000790	+0·002563	+0·000650	−0·001250	−0·003097	−0·003057	−0·000557	−0·004183	−0·003583
IV. "	−0·001157	−0·001254	−0·002664	−0·001570	+0·000149	−0·001304	+0·001583	+0·003329	+0·001629	−0·000537	+0·004109	+0·005430
Equinoc. } quarters.	+0·000723	+0·001417	+0·002062	+0·000687	+0·000317	+0·000064	−0·001210	−0·002737	−0·003347	−0·002033	−0·003390	−0·001686
Solstitial } quarters.	−0·000812	−0·001781	−0·000599	−0·000782	+0·000291	−0·001162	+0·000258	+0·001661	+0·001474	+0·000721	+0·004041	+0·004655
Apr. to Sept.	−0·000007	+0·000013	+0·001797	+0·000367	−0·000023	−0·000630	−0·001587	−0·001913	−0·001480	−0·001267	+0·000590	+0·004620
Oct. to Mar.	−0·000044	−0·000206	−0·000301	−0·000424	+0·000669	−0·000431	+0·000672	+0·000876	−0·000354	−0·000008	+0·000082	−0·000614
Year	−0·000019	−0·000090	+0·000754	−0·000172	+0·000329	−0·000524	−0·000451	−0·000512	−0·000911	−0·000631	+0·000344	+0·002009

The curves derived from the results of this Table are shown on Plate XI., with the exception of the semiannual and annual curves which may be studied on Plate X.

Glancing at the various curves thus resulting, we are first struck by the great conformity of some of them, whilst others present irregularities apparently quite irreconcileable with what we feel inclined to adopt as the law. There is, however, in all cases manifested a progressive change, evidently depending on the moon's hour-angle in the first instance, calling for a rigorous examination. The semiannual curves of the lunar-diurnal variation of atmospheric pressure may be taken as representing the principal types of the various monthly curves. During the sun's absence from the hemisphere (in our case, when the sun's declination is north), from April to September, the lunar variation reaches its maximum at about $23^h\ 15^m$, or 45^m prior to the moon's upper transit, its minimum value occurring at 19^h and a secondary one at 2^h, with a range of 0·00653 inch. The curves for the single months appertaining to this semiannual period exhibit, generally speaking, the same characteristics, though somewhat irregular, and showing, in some instances, deviations of considerable extent; so, for instance, the curves for August and September. The summer semiannual curve (while the sun's declination is south) exhibits an essentially different character, there being no strongly expressed maximum noticeable, whilst a decided minimum occurs at $0^h\ 30^m$ or 30^m past the moon's upper passage, the maximal pressure taking place at 6^h, and a secondary one between 18^h and 19^h. The amplitude of oscillation amounts to 0·00432 inch. But in this period of the year we notice a great difference in the lunar-diurnal variation of the barometer, when we examine the single months somewhat more closely; thus, for instance, the curve for the month of December shows such characteristics as to cause it to be more like the curves for the winter period, and, on the other hand, we perceive that the curve for the month of November is exactly of the opposite character as that for December. The remaining four months show more or less irregularity, and make a greater or smaller approach towards the general type for the class under consideration.

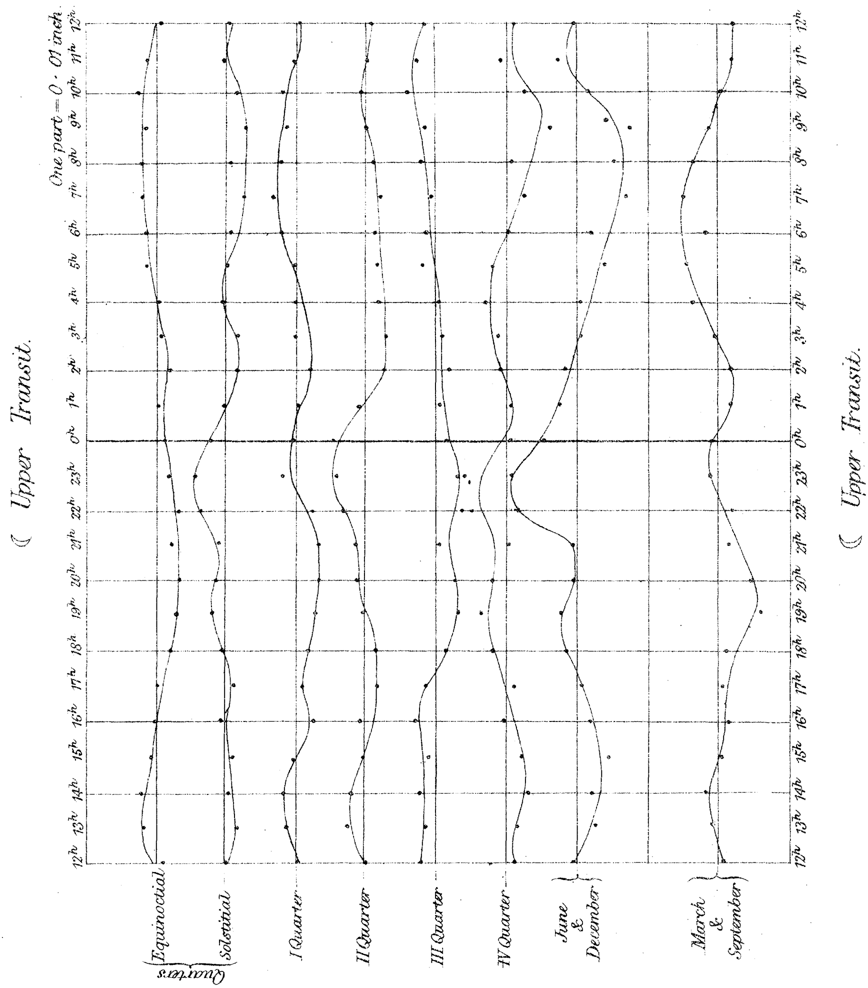
Although there is undoubtedly in all of these cases strong evidence of an influence of the moon on our atmosphere, I could not rest satisfied, considering that this evidence is seemingly of a somewhat conflicting nature. As already explained, the monthly values have, for the purpose of further inquiry, been combined into quarters, and the results for these quarters were again united in mean values, arranging the two quarters in which epochs of solstice occur, and the remaining two, comprising the equinoxes, respectively, in two groups. Thus we obtain six monthly mean values of the lunar-diurnal variation for the "solstitial and the equinoctial quarters." I was prompted to adopt this course because of the great similarity of the curves for December and June in the one case, and of March and September in the other, though in by far less a degree. This similarity may best

☾ Upper Transit.



☾ Upper Transit.

J. Basire lith.



J. Basire lith.

be judged by the mean values for the respective two months, representing, as they do, in both cases a distinct oscillation with an amplitude of $0''\cdot01722$ for the solstices, and of $0''\cdot01041$ for the equinoxes. I may be allowed to refrain from adding here these mean values, suffice it to refer to the respective curves at the bottom of Plate II. For December and June we observe the maximum to occur at 23^h, the minimum at or shortly after 8^h, while for September and March the maximum in the lunar-diurnal variation of pressure of air takes place at 7^h and the minimum at 19^h. The mean for the quarters (each embracing six months) show the same characteristics, though by far less in extent, the amplitude for the solstitial quarters being $0''\cdot007454$, and that for the equinoctial quarters $0''\cdot006334$.

There is another fact which requires to be pointed out, in order to throw further light upon the character of these oscillations; namely, that they seem to bear a great resemblance for both hemispheres during the same semiannual period, if we are permitted to arrive at this conclusion by referring to Prof. Kreil's discussions of his observations at Prague (Versuch den Einfluss des Mondes auf den atmospherischen Zustand unserer Erde aus einjährigen Beobachtungen zu erkennen, 1841). The semiannual curves of the lunar-diurnal variation of the barometer at Prague and Melbourne closely correspond during the months from April to September, and from October to March, which seems to point to some cause common to the whole globe in a similar manner, as we know it to be with respect to the extent of the rise of the oceanic tides at the time of the solstices and equinoxes. It would be premature to enter now upon any speculation with a view to bring the results of our observations in accordance with theory, there being still by far too few discussions on atmospheric tidal observations at our command.

The yearly curve of the lunar-diurnal variation presents some peculiarly interesting features, differing in some respects from the results of similar inquiries instituted by General Sabine and Capt. C. M. Elliot with special regard to the lunar atmospheric tides at St. Helena and Singapore, although the plan of discussion was the same. The lunar horary variation of the barometer is as follows, "if we arrange the results in such manner that the hours are combined in which the moon is similarly situated in respect to the meridian" (Sabine's paper "On the Lunar Tides at St. Helena"):—

Moon's distance from the meridian.	Variations of barometric pressure. At the hours following the meridian passage.			Variations of barometric pressure. At the hours preceding the meridian passage.			Horary variation from the observations at the hours following the meridian passage.	Horary variation from the observations at the hours preceding the meridian passage.	Horary variation Mean.	Moon's distance from the meridian.
h	h	in.	in.	h	in.	in.	in.	in.	in.	h
0	0 12	+0·00039 − ·00002	+0·00018	0 12	+0·00039 − ·00002	+0·00018	+0·00073	+0·00087	+0·00080	0
1	1 13	− ·00035 − ·00009	− ·00022	11 23	+ ·00079 + ·00201	+ ·00140	+ ·00033	+ ·00209	+ ·00121	1
2	2 14	− ·00157 + ·00075	− ·00041	10 22	+ ·00094 + ·00034	+ ·00064	+ ·00014	+ ·00133	+ ·00073	2
3	3 15	− ·00093 − ·00017	− ·00055	9 21	− ·00076 − ·00063	− ·00069	·00000	·00000	·00000	3
4	4 16	+ ·00001 + ·00033	+ ·00017	8 20	+ ·00054 − ·00091	− ·00018	+ ·00072	+ ·00051	+ ·00061	4
5	5 17	+ ·00040 − ·00052	− ·00006	7 19	− ·00004 − ·00051	− ·00027	+ ·00049	+ ·00042	+ ·00045	5
6	6 18	+ ·00044 − ·00045	·00000	6 18	+ ·00044 − ·00045	·00000	+ ·00055	+ ·00069	+ ·00062	6

In both cases, at the hours following, and at those preceding the meridian passage, the minimum is decidedly at the 3rd hour, while the maximum in the first series occurs at the 0th, and in the second at the 1st hour. At Singapore and St. Helena, both within the tropics, the lunar-diurnal variation shows a maximum at the 0th and a minimum at the 6th hour. The discussions, based on observations made at Prague, and already referred to above, exhibit a greater conformity in respect to the lunar tides at Melbourne than any of the tropical stations. This conformity is especially clearly expressed in the series for "the hours following the meridian passage" (which series seems to present in each respective case the greatest reliability), and we observe that the minimum occurs at the 3rd and 4th, and the maximum at the 6th hour. But in turning Prof. Kreil's labours in this direction to account, we must remember that they refer to a period of only one year, and cannot be considered as presenting great guarantees for decisive results, especially when considering that so high a latitude as 50° 8′ N. would rather have required a longer period of observation than is necessary to prove the existence and character of the lunar atmospheric tides within the tropics. So very few discussions on this topic being at our command, it is nevertheless of considerable interest to compare the results for Prague with those at St. Helena, Singapore, and Melbourne, as done in the following little Table :—

	Mean of three years at Singapore (+1° 19′).	Mean of two years at St. Helena (−15° 57′).	Mean of five years at Melbourne (−37° 48′).	Mean of one year at Prague (+50° 8′).	
h	in.	in.	in.	in.	h
0	+0·00570	+0·00365	+0·00080	0·00000	0
1	+ ·00475	+ ·00336	+ ·00121	+ ·00043	1
2	+ ·00330	+ ·00275	+ ·00073	+ ·00080	2
3	+ ·00280	+ ·00158	·00000	+ ·00039	3
4	+ ·00145	+ ·00110	+ ·00061	+ ·00005	4
5	+ ·00035	+ ·00046	+ ·00045	+ ·00032	5
6	·00000	·00000	+ ·00062	+ ·00078	6
Mean......	+ ·002621	+ ·001843	+ 0·00631	+ ·000396	Mean.

The decrease in extent of oscillation, as we recede from the equator, is clearly illustrated by the mean values of this Table.

Speaking of the extent of the oscillations, it is of importance to add a few facts relative to the amplitude, as resulting from the monthly curves. We have seen, in the course of this exposition, that the amplitude for the semiannual periods from April to September, and from October to March, is respectively 0″·00653 and 0″·00432, which result will be materially altered in case we consider only the single months; for inasmuch as the sense of oscillation varies considerably in the single months, constituting a semiannual period, chiefly during summer, the combination of the hourly values of six months in one group must necessarily tend to diminish, or

even abolish in some cases, the lunar-diurnal variation. The mean amplitude of the lunar-diurnal variation of atmospheric pressure for the several months, as represented by the means of five years, is as follows :—

	April	0″·0069	May	0″·0171	June	0″·0165
	Oct.	·0091	Nov.	0·0311	Dec.	·0222
Means for two months equidistant from the equinox		·0080		·0241		·0194
	July	0·0131	Aug.	0·0109	Sept.	0·0133
	Jan.	·0108	Feb.	·0093	Mar.	·0139
Means for two months equidistant from the equinox		·0199		·0101		·0136

The semiannual means are, for the six winter months (when the sun's declination is north), 0″·0129, and for the summer months (when the sun's declination is south) 0″·0161, and therefore the mean amplitude in lunar-diurnal variation of the barometer is 0″·0145.

There is evidently a great conformity in the change in extent of oscillation observable, when we examine the semiannual values of the above series. In April and October the amplitude reaches a minimum value, whilst in the months immediately following a maximum occurs. For both the equinoctial months the value in question is nearly alike, making at the same time the nearest approach to the annual mean. The months following the equinoxes exhibit the smallest range in lunar-diurnal variation of atmospheric pressure, whilst those months preceding the solstices are to be considered as maxima with respect to the value at issue.

With a view to ascertain whether the difference in the extent of the lunar atmospheric tide at the epochs of apogee and perigee may be proved to be perceptible in as high a latitude as 37° 48′, I followed a course differing in some respects from the one proposed by General Sabine in his discussions of the St. Helena observations. We have seen that in the case under consideration the hours of the extremes in pressure are not marked in a like distinct manner as for places near the equator, and I thought it on this account preferable to abandon the adherence to certain hours of the lunar day in determining the range in the value $b-\bar{b}$, simply adopting this range for the lunar day near the apogee or perigee, irrespective of any hour of maximum or minimum. In order to increase the number of comparisons, this range was determined in addition to the days of apogee and perigee for the day preceding and that following those epochs. The difference in the lunar-diurnal range in atmospheric pressure at the epochs of perigee (R^p) and apogee (R^a) was consequently in each case derived from six days' observation. Thus we obtained the following values for R^p-R^a, which, however, cannot be immediately compared, in respect to the amount, with the corresponding values of the discussion on the St. Helena observations just referred to and arrived at by a different process.

Months.	Lunar-diurnal range in Perigee minus lunar-diurnal range in Apogee.					
	1858–59.	1859–60.	1860–61.	1861–62.	1862–63.	Mean for 1858–63.
	in.	in.	in.	in.	in.	in.
April	+0·0775	+0·1793	+0·1910	−0·0984	+0·1010	+0·09018
May	+ ·1146	− ·2270	+ ·0220	+ ·0676	− ·1363	− ·03182
June	− ·0251	− ·0376	+ ·0960	+ ·0380	− ·0837	− ·00248
July	− ·1279	+ ·0786	− ·0020	− ·0044	− ·0370	− ·01246
August	− ·0148	+ ·0217	− ·0750	+ ·1044	+ ·0587	+ ·01904
September	− ·0128	+ ·0144	+ ·1070	+ ·0180	− ·0417	+ ·01968
October	+ ·1004	+ ·1506	+ ·0400	+ ·2006	+ ·1820	+ ·15477
November	+ ·0287	+ ·0320	+ ·0160	+ ·0360	− ·0870	+ ·00514
December	+ ·1439	− ·0296	+ ·0760	− ·1000	+ ·0020	+ ·01846
January	+ ·0097	− ·0083	+ ·0805	+ ·0177	− ·0270	+ ·01452
February	+ ·0815	+ ·0570	− ·0010	+ ·0727	+ ·0510	+ ·05224
March	+ ·0053	+ ·1217	− ·0486	− ·0410	+ ·0060	+ ·00868
Means	+ ·04418	+ ·02747	+ ·03605	+ ·02808	+ ·00195	+ ·02746
Number of epochs of Perigee..	13	13	14	13	13	66 Sum.
Number of epochs of Apogee...	14	13	13	13	14	67 Sum.

The mean value of +·02746 was derived with due regard to the number of epochs of apogee and perigee occurring in the whole period of observation, the total number of barometrical readings from which it was derived being 720.

There can hardly exist a doubt, after having examined the above results, that the lunar-diurnal range in pressure of air at the time of the perigee exceeds the one at the apogee, a fact which is also in strict accordance with theory. But it ought to be pointed out that during the months of May, June, and July the reverse seems to take place, as is manifested in every one of the five years of observation. Whether this bears any reference to the time of aphelion on the 3rd of July, and the time of the perihelion on the 2nd of January, we do not pretend to decide now; suffice it to have directed the attention of those more immediately interested in inquiries of this nature to a matter replete with so much interest, but as yet, comparatively speaking, scantily examined. The mean range for the epochs of perigee and apogee is respectively 0″·16327 and 0″·13581, resulting a general mean range of 0″·149540.

A similar plan to that just described was pursued, in order to ascertain whether there existed any perceptible difference in atmospheric pressure in the periods of syzygy and quadrature. The range of the atmospheric pressure during a lunar day was determined for days of full and change, and also for each of the epochs of quadrature separately, and furthermore for the day preceding and following each of the several epochs. Subsequently a mean value was derived by combining the daily

range of the epochs of syzygy (R^s) and that for the epochs of quadrature (R^q).

Months.	Lunar-diurnal range in pressure of air.						Difference, R^s-R^q.
	Full moon.	New moon.	First quarter.	Last quarter.	Mean for the epochs of		
					Syzygy.	Quadrature.	
	in.	in.	in.	in.	in.	in.	in.
April	0·1507	0·1632	0·1728	0·1224	0·15695	0·14760	+0·00935
May	·1312	·1730	·1669	·1399	·15210	·15340	− ·00130
June	·1125	·1463	·1557	·1282	·12940	·14195	− ·01255
July	·1656	·1311	·1451	·1145	·14835	·12980	+ ·01855
August	·1532	·1585	·1095	·1872	·15585	·14835	+ ·00750
September ...	·2103	·1667	·1497	·2071	·18850	·17840	+ ·01010
October	·1597	·2038	·1797	·1557	·18175	·16770	+ ·01405
November ...	·1318	·1582	·1648	·2208	·14500	·19280	− ·04780
December ...	·1907	·2191	·1226	·1800	·20490	·15130	+ ·05360
January	·1729	·1287	·1518	·2059	·15080	·17885	− ·02805
February ...	·1073	·0662	·1246	·1154	·08675	·12000	− ·03325
March.........	·1262	·1509	·1155	·1448	·13855	·13015	+ ·00840
Means.........	·15101	·15547	·14656	·16016	·153242	·153360	− ·000118

The last column of this Table shows the difference R^s-R^q, so that plus denotes an excess of the lunar-diurnal range at the periods of syzygy, and minus an excess at the periods of quadrature.

According to the above there is a decided minimum in the lunar-diurnal range at the time of the first quarter, while the last quarter seems to be the maximum, the time of the syzygy showing intermediate values. The general mean would indicate an excess, though very small, in favour of the epochs of the quadrature. On examining, however, the difference for the single months, we notice that the algebraic sign denotes for seven months an excess of the epochs of syzygy, and for five only the contrary; further, that the greatest irregularity in respect to the signs and values prevails durings the months from November to February, when hot winds are most frequent, and the sudden changes in temperature, connected with these phenomena, cause the oscillations of the barometer to be much disturbed. The magnitude of the values during this period ought to induce us to receive them with caution, and to consider the eight remaining months separately. The general mean difference for the eight months, from March to October, both inclusive, represents an excess in favour of the epochs of syzygy of 0·006762 inch, a value which most probably makes a near approach to truth.

If we derive mean values of the lunar-diurnal range for the several years of observation at the respective phases of the moon, we have—

Years.	Lunar-diurnal range in pressure of air.						$R^s - R^q$.
	Full moon.	New moon.	First quarter.	Last quarter.	Mean for the epoch of		
					Syzygy.	Quadrature.	
	in.	in.	in.	in.	in.	in.	in.
1858–59.	0·16526	0·14492	0·14627	0·17259	0·15506	0·15943	−0·00437
1859–60.	·13682	·14272	·15817	·15354	·13977	·15585	− ·01608
1860–61.	·14017	·16672	·12792	·14953	·15344	·13872	+ ·01472
1861–62.	·12969	·15270	·14664	·19473	·14119	·17068	− ·02949
1862–63.	·18316	·17752	·14802	·13102	·18034	·13952	+ ·04082
Means	·151022	·156916	·145404	·160282	·153969	·152843	+ ·001126

The final result of this Table shows an average excess of 0″·001126 in favour of the epochs of syzygy, but an analysis of this value shows that for three years the excess is in favour of the epochs of quadrature, while but two years seem to confirm what we feel inclined to regard as the rule. So much we are able to assert, however, that the lunar-diurnal range in pressure of air at the time of the first quarter shows a minimum, and that near the last quarter and new moon a maximum in this range seems to make itself manifest. Although the evidence adduced in the case is not of such a positive nature as that produced when treating on the question of the increased pressure of air near the perigee, we feel nevertheless inclined to believe some similar relation to exist between the atmospheric tides and the moon's phases, as we know to be the case with respect to the oceanic tides, and that a more rigorous inquiry into this question than we are able on the present occasion to institute, will ultimately yield a result in strict accordance with the theory of gravitation.

Before concluding these researches I may be allowed to point out a fact corroborative of the result arrived at when speaking of the difference of atmospheric pressure near the epochs of syzygy and quadrature. The mean diurnal range resulting from the last inquiry amounts to 0″·153301; but on the former occasion we found this range to be 0″·14954. The excess of 0″·00376, of which the lunar-diurnal range of the atmospheric pressure is larger, when derived from the epochs of the moon's phases, than when obtaining it by the periods of perigee and apogee, must be attributed to the fact that in the latter case sixty-six periods of perigee were combined with sixty-seven periods of apogee, giving a fair average result; while in the former forty-three epochs of perigee and but thirty-five of apogee happened to coincide with the several phases of the moon, tending in this way to raise the mean value of the lunar-diurnal range of the barometer above that average.