Hartmann number. For either zone, it is concluded that the effect of increasing the Hartmann number is always to increase the film thickness. This can be reasonably expected as the applied magnetic field B_0, transverse to the wall, *i.e.*, in the positive *x*-direction as showin in Fig. 1 (see also Fig. 1 of Annapurna and Ramanaiah[3]) will always have a tendency to pull the fluid in its own direction.

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LUNAR TIDES IN EQUATORIAL IONOSPHERIC ABSORPTION*

Introduction

LUNAR tides in ionospheric absorption of radiowaves have been studied by several workers.[1-6] In these studies both diurnal and semi-diurnal tides have been observed, the latter being predominant. However, such studies of lunar tides in ionospheric absorption at equatorial latitudes have been inconclusive. This communication deals with the study of the lunar tidal effect on absorption measured at Waltair (17° 43′ N) and the results are compared with those available for the other latitudes.

Data and Method of Analysis

The noontime values of absorption (L) obtained from A_1 technique on two frequencies 2·4 MHz and 5·6 MHz during the period 1971–76 and 1975–76 respectively have been utilised in the present analysis. The 'L' values affected by solar flares, sudden commencement etc. are excluded from the data. Following the method of Chapman and Bartles[7], the data have been subjected to harmonic analysis to obtain the amplitude and phase.

Results and Discussion

The results of the present analysis (Table I) show that the amplitude of the semi-diurnal tide is greater than that of the diurnal tide at both the frequencies. Moreover, the amplitude of the diurnal and semi-diurnal tides decreases with increase of the operating frequency as seen from Table I. Ganguly[6], while studying absorption of radiowaves covering a large number of frequencies, has observed maximum tidal effect for frequencies near foE and a decrease in amplitude of the tide for frequencies greater than the critical frequency of the E-layer.

TABLE I

Diurnal and semi-diurnal periodicities in the Lunar tide of ionospheric absorption at Waltair

Period of study	Frequency MHz	$L_1(A)$ a_1	$L_1(A)$ φ_1	$L_2(A)$ a_2	$L_2(A)$ φ_2	Time of max. of L_2 (Lunar hours)
1971–76	2·4	0·35	17	0·52	59	1·0
1975–76	5·6	0·10	358	0·28	231	7·3

Another important feature evident from Table I is the phase reversal in the E-region and F-region tides. Chakravarthy and Rastogi[8] observed a phase reversal in D-region and F-region lunar tides over Singapore. The results of multifrequency studies of Rao[9] and Ganguly[6] indicated a phase reversal between the D-region and F-region lunar tides, though they did not mention explicitly reversals in their studies.

The seasonal variation of the semi-diurnal component for the frequency 2·4 MHz for which the data coverage was maximum is shown in Table II. The magnitude of the lunar tidal variation of ionospheric absorption is larger in winter than the corresponding values for summer and equinox. This is in good agreement with the seasonal studies made at Colombo[10], Singapore[8] Calcutta[6] and Freiburg[4]. Further, the lunar tide of maximum absorption varies slightly with season, during the sunspot minimum period. It may be worth while mentioning a similar conclusion

TABLE II

Seasonal variation of lunar semi-diurnal component for 2·4 MHz

	Amplitude (in db) a_2	Phase (in degrees) φ_2	Time of max. a_2 after transit (in lunar hrs.)
Winter	0·88	114	11·2
Equinoxes	0·65	19	2·4
Summer	0·64	60	1·0

reached by Chakravarthy and Rastogi[10] that the phase of the lunar tide in the ionospheric absorption at Colombo does not change appreciably with season during low Sunspot year, but large seasonal variation during the high sunspot years. Chakravarthy and Rastogi[8] also observed slight variation in phase of the lunar tide with season during sunspot minimum for Singapore data.

The lunar semi-diurnal component for the annual mean attains a maximum at 0100 hrs. lunar time for E-region (2·4 MHz) and the semi-diurnal component of pressure oscillations at the ground attains a maximum at 0100 hrs. and 1300 hrs. The lunar barometric oscillation at ground at Bombay is given[11] by 49 Sin $(2wt + 81)$ microbars. Since Bombay is just 1° N of Waltair, the above expression may be taken to give the lunar barometric oscillation at Waltair. This expression indicates that the barometric pressure reaches a maximum at Waltair about 20 minutes after lower transit of the moon. Thus, the phase of the lunar tide in absorption as brought out from the analysis is almost the same as that of the phase of the lunar pressure oscillations at ground. A comparision of lunar semi-diurnal tide for low sunspot activity period in ionospheric absorption at low latitude stations like Colombo[12] and Ibadan[8] shows that the phase agrees broadly with that of the ground semi-diurnal lunar barometric pressure oscillation at the respective places. In fact, it has been observed that the semi-diurnal tide in ionospheric absorption and the corresponding tide in barometric pressure at ground is well correlated both in phase and amplitude for the Slough data also. Shrestha[13] presents evidence of association of abnormally high incidence of ionospheric absorption of radiowaves and microbarometric oscillations at ground at Brisbane.

It may be mentioned however the phase of the semi-diurnal component for 5·6 MHz absorption data does not agree with that of the semi-diurnal component of f_0F_2 at Waltair latitude[14].

Chapman and Bartles[7] observed that the phase of the semi-diurnal component of ground pressure oscillations changes from roughly 0100 hrs. at ground level to 6·5 hrs. after local transit at some level below the Dynamo region to explain the observed magnetic variations. If this phase change remains unaltered above the dynamo region, then the phase of semi-diurnal component at 5·6 MHz absorption tide may be explained as arising due to pressure changes in the F-region.

To evaluate the variation of ionospheric absorption with dip latitude, Gnanalingam[15] has plotted the normal absorption values on 2·2 MHz at $\chi = 0$ and $R_z = 0$ with the dip angles of different stations as shown in Fig. 1. The curve shows the maximum absorption around 20° dip latitude. For comparison, the amplitudes of the semi-diurnal lunar oscillation for the sunspot minimum years have also been plotted in the same figure for the stations where the data have been analysed for lunar tides. It is evident that the amplitude 0·52 obtained in the present investigation lends support to the argument made by Chakravarthy and Rastogi[8] that the maximum amplitude of the lunar tide in absorption occurs also at stations around 20° ± 5° dip latitude.

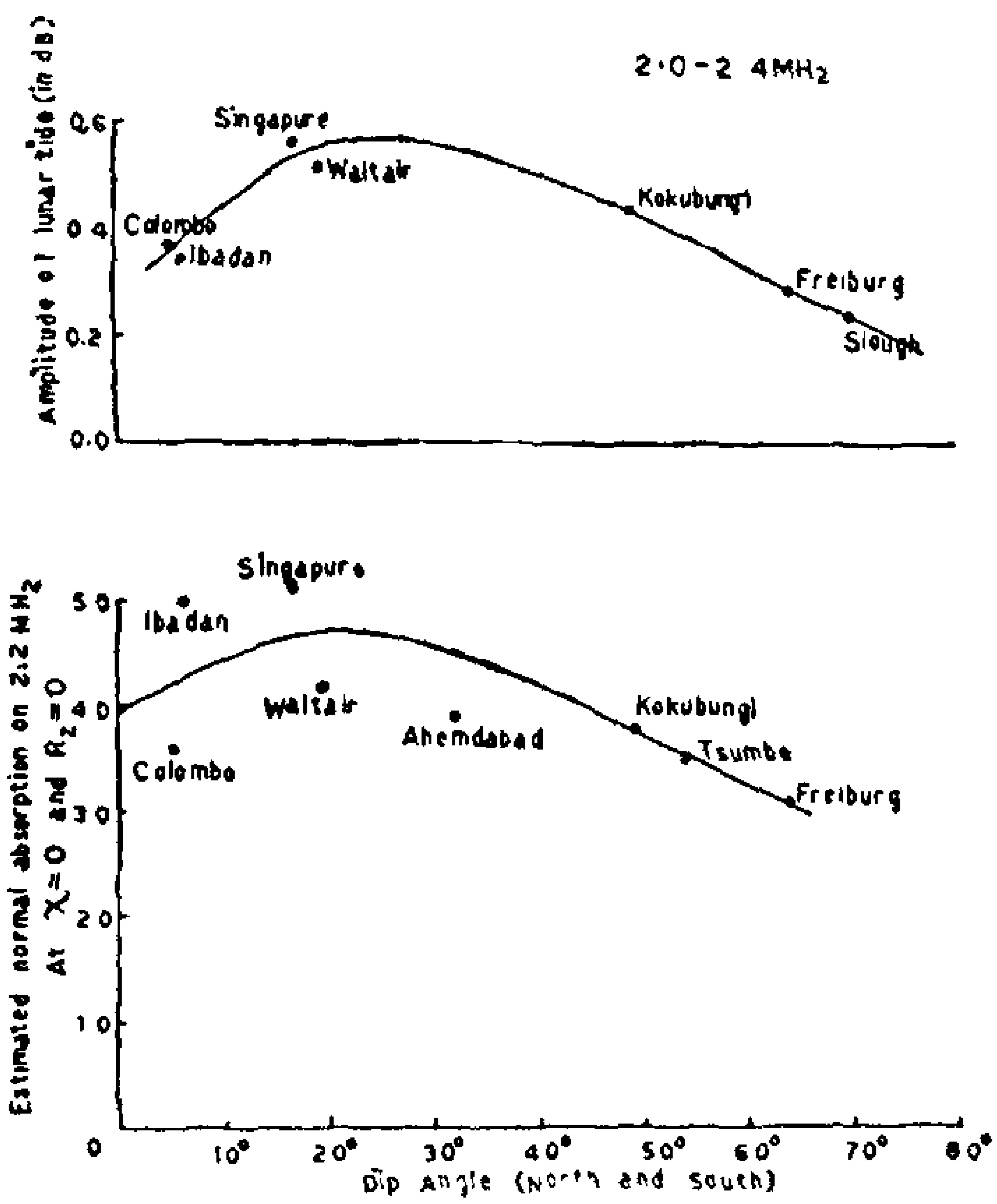

FIG. 1. Variation of the average amplitude of lunar tide in absorption and the normal absorption with the dip angle.

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