LETTERS TO THE EDITOR

ON THE OCCURRENCE OF LONG RANGE INTERFERENCE OBSERVED WITH METEOR WIND RADAR

The Meteor Wind Radar at the Nagarampalem field station of Space Research Laboratories, Andhra University, Waltair (17° 43′, 83° 18′ E) is a pulse doppler radar of 20 kw peak power, operating at 36 MHz with pulse repetition frequency of 450 Hz and a pulse length of 25 μ sec. Basically the radar is constructed for neutral wind measurements at meteoric heights with its two 8-element twin Yagi arrays situated in NW and SW directions.

By continuous operation of the radar with its NW aerial, the effect of ionospheric ambient ionization on long duration echoes, and the VHF absorption measurements at meteoric heights are under study. While taking observations during the above investigations, multiple echoes extending over the full time base and giving a patchy appearance are being observed very frequently in the afternoon hours. Fig. 1 illustrates one such type of the observed patchy pattern. Fig. 2 illustrates the normal record of a meteor echo.

Some of the observed characteristics of these patchy reflections are as follows:

1. The onset time is usually between 1300 hrs. and 1600 hrs. IST and persists upto sunset and sometimes for even one or two hours after sunsets.
2. There are occasions when the patchy echoes commenced even before noon, sometime between 1100–1200 hrs IST, but such instances are very rare.
3. The frequency of occurrence is quite high, almost four to five days in a week.
4. About half an hour before the onset of patchy echoes, there is an appreciable drop in the meteot echo rate.
5. The onset is not sudden but very gradual. First the persistent echoes appear at the extreme end of the time base, indicating a range of 333 km and gradually shift towards the beginning of the time base.
6. These persistent echoes could be clearly distinguished from the meteor echoes from the facr that meteor echoes from underdense trails disappear within a fraction of a second and even those from overdense trails usually decay within a few seconds, very rarely within a few minutes.
7. Once these persistent echoes occupy the complete time base of the display oscilloscope, the whole pattern looks like a patch almost similar to the spread F patch observed during nights with the ionospheric vertical sounding equipment.
8. There is non-uniform distribution of amplitude over the entire patch and different portions of the patch are found to exhibit fading with different frequencies, which suggests the possiblity of interference between radio waves back scattered *via* different paths.
9. The patchy echoes are observed on both the NW and SW antennas simultaneously suggesting that the source of scatter has an extent of several hundreds of kilometers, depending upon the height of the scattering source above the earth', surface.

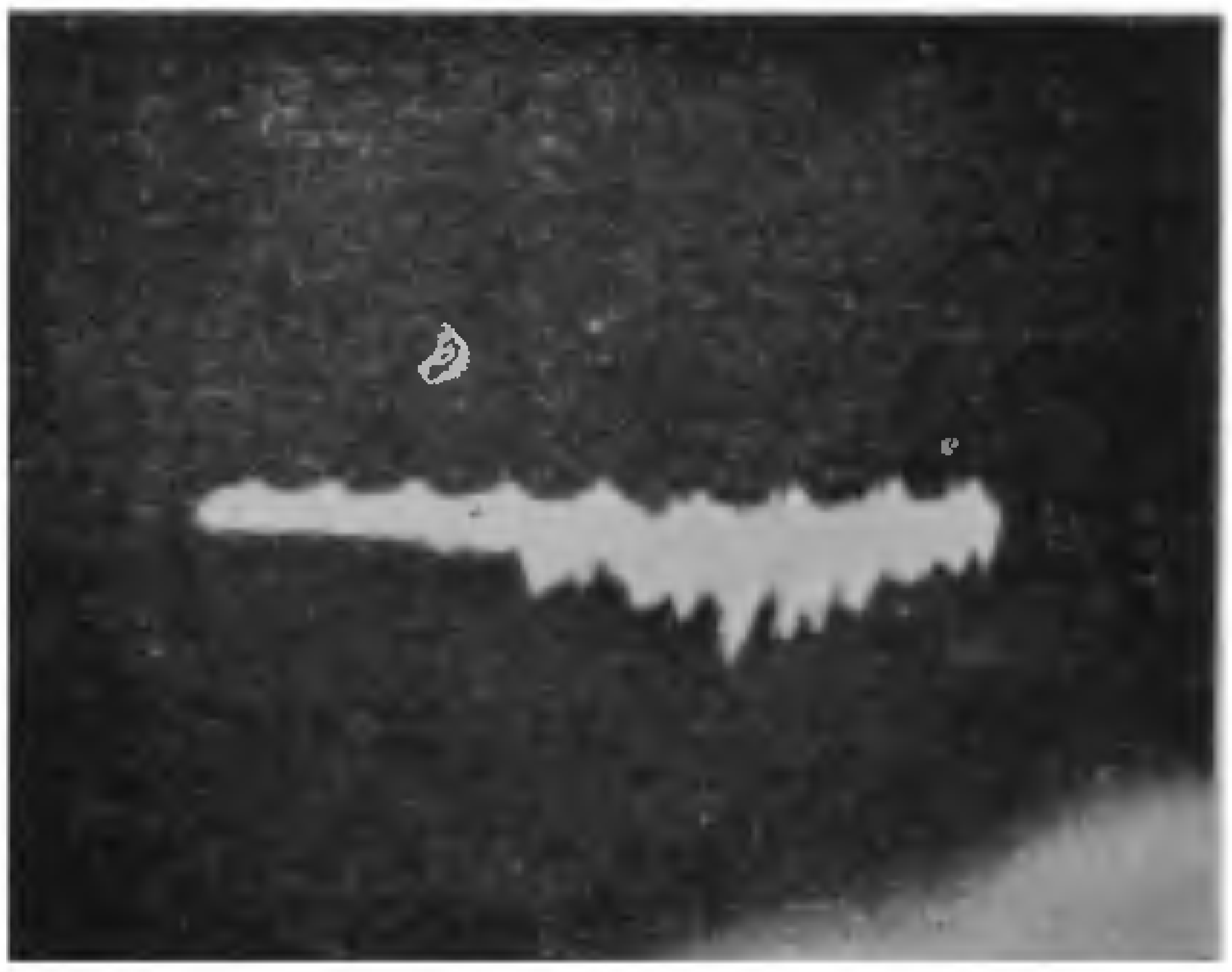

FIG. 1

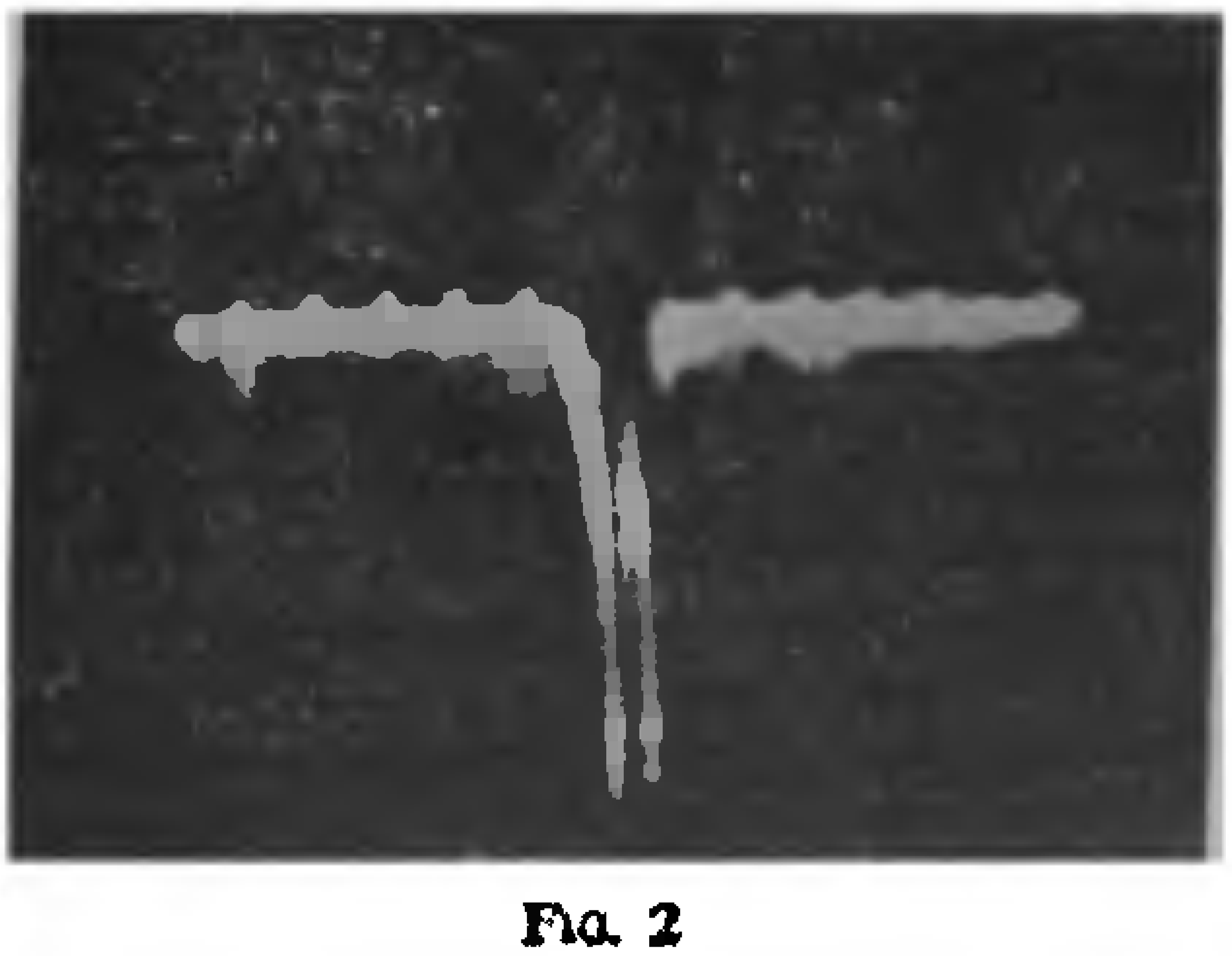

FIG. 2

Some of the earlier investigators[1] have also observed this type of patchy echoes and interpreted them as land and sea clutter. This possibility can be over-ruled in the present case because the receiver is suppressed for the first 70 km range during each span of 333 km. Before attempting to look into the possibilities of this type of scatter, it would not be out of place here to mention the range measuring capabilities of the meteor wind radar. Since the pulse repetition frequency of the radar is 450 Hz, the maximum unambiguous range of the radar is 333 km. This is further extended to 666 km and 999 km by transmitting in a sequence of one double pulse followed by two single pulses at equal intervals of 2·2 m sec. So a double pulse echo represents a range from 0 to 333 km and a single pulse echo represents a range of 333 to 666 km or 666 to 999 km. During each span of 333 km, the receiver is suppressed for the first 70 km, since meteor echoes are not expected to occur at these small ranges. The receiver therefore is interrupted between 0 and 70 km, 333 and 403 km, and 666 and 736 km and so on.

If one tries to interpret the observed patchy type of scatter, the following possibilities are to be considered.

(*a*) Land and sea clutter
(*b*) Scattering by the electrojet
(*c*) Scattering by sporadic E layer
(*d*) Scattering by F region.

Direct clutter from the land and sea cannot cause interference because the radar receiver is suppressed from 0 to 70 km. The observed patchy echoes cannot be due to scatter by the sea directly because the antenna beam centre has an elevation of nearly 30°. However, the power could be directed towards the sea by the ionosphere and scattered back *via* the same path. The possibility of sea-ionosphere scatter is very remote in the present case because the antennas look towards NW or SW direction whereas the sea is mostly towards East of Waltair, and covering directions from South to North-East.

Scattering by the equatorial electrojet irregularities also can be ruled out because Waltair (20° dip latitude) is well outside the electrojet region of ± 5° dip latitude. Scattering by E_s layer is quite possible since E_s occurs during day time also. Whenever the patchy echoes are observed by the Meteor Wind Radar, the vertical pulse sounding equipment is switched on to verify the presence of E_s. But these two phenomena do not seem to be correlated since there have been larger number of incidents when patchy echoes were observed when there was no E_s formation. Since the radar antennas do not look vertically, but look at an elevation of 30°, it is quite likely that E_s might be present in the regions illuminated by the antennas. Assuming an average height of occurrence of E_s to be 110 km, above the earth's surface, for an antenna elevation of 30°, the region illuminated by NW antenna would be vertically above a place situated 190 km away from Waltair in the North-Westerly direction. If an ionosonde were to be located at this place, probably it would have indicated the presence of sporadic E layer. Similarly an ionosonde located 190 km away from Waltair in the South-Westerly direction would have shown the presence of E_s. The fact that patchy echoes were found on both the NW and SW antennas at the same time would mean that if E_s at a level of 110 km is the source of scatter, it should exist simultaneously at two regions situated at least 269 km apart. Since E_s occurrence is a localized phenomenon, the possibility of its occurrence simultaneously at two places separated by 269 km is quite remote.

The F_2 region of the ionosphere seems to be main source of scatter. It is the usual characteristic of the F_2 region that the diurnal variation of the critical frequency f_0F_2 exhibits two peaks on either side of noon, with a biteout at noon. Though the patchy echoes are seen rarely at forenoon hours, since the afternoon peak has a larger amplitude than the forenoon peak for low latitude stations, the patchy echoes observed at forenoon hours are not significant and the f_0F_2 approaches 13 to 14 MHz around 1400 hrs to 1500 hrs IST.

Since the beam centre of the antenna has an elevation of nearly 30° and beam width of 30° in the elevation plane, the power is radiated obliquely between 15° and 45° of elevation approximately. For the transmistting frequency of 36 MHz, the equivalent vertical frequency would therefore vary from about 9 MHz to 25 MHz. So when the critical frequency of the F_2 region exceeds well above 9 MHz power radiated at low elevation angles is likely to be scattered back by the F_2 region. Some power may be directly back scattered by the F_2 region and some power may be forward scattered towards the ground and again scattered back towards the antenna *via* the F_2 region. Assuming an average level of 300 km for the peak of the F_2 region, the power transmitted by the antenna at low elevation angles of 15° to 30° and directly back scattered will give rise to echoes in a range interval of 1150 km to 600 km respectively. These echoes will appear on the display unit as multiple-time-around echoes on a range trace of 0 to 333 km. The echoes due to power scattered *via* F_2 region-ground-F_2 region path would have much larger ranges. The observed irregular fading of the echoes may be due to interference between the waves directly back scatterrd by the F_2 region and those scattered *via* ground-F_2 region path.

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STUDIES ON ALIZARIN MAROON, ALIZARIN SAPHIROL B AND ALIZARIN HELIOTROPE COMPLEXES OF Mn(II), Fe(II), Co(II), Ni(II) AND Cu(II)

CONSIDERABLE interest has been shown recently in the complex formation by amino-anthraquinone dyes and their related compounds[1-5]. In the present paper we have studied the possibility of alizarin maroon (AZM), alizarin saphirol B (AZSB) and alizarin heliotrope (AZH) to form stable complexes with some divalent transition metal ions. The composition and structure of the complexes formed are studied using spectral and conductivity data.

Experimental

The solid complexes were prepared by mixing the appropriate amount of the ligand solution (10^{-3} M) with the accurately weighed quantity of the metal salt (dissolved in ethanol). The mixture was refluxed for 10 min. on a water bath and cooled. The solids were filtered off, washed with acetone, dried and analysed. The solid complexes having the metal: ligand ratios 1:1 and 1:2 were isolated.

The absorption spectra of solutions were recorded on a UNICAM S.P. 8000 spectrophotometer and the i.r. spectra were recorded on a Beckman Infrared Spectrophotometer as KBr discs.

Results and Discussion

The visible spectrum of AZH in ethanol shows a main absorption band at 480 nm[6] which shows a red shift on addition of metal ions.

The formation of AZM and AZSB metal complexes are pH-dependent. The results indicate that the optimum pH is $\sim$ 7·5 for the formation of Fe(II) and Cu(II) complexes and 8–8·5 for the Mn(II), Co(II) and Ni(II) complexes. The obvious red shift of the bands shown by AZM and AZSB complexes in comparison with those of the free ligands[6,7] at the same pH, indicates the complex formation. In Table I, are given the values of λ_{max} for the different complexes.

The stoichiometry of the mixed ligands in solution was determined by Job's continuous variation[8] and also by molar ratio[9], straight line[10], slope ratio[11] and limiting logarithmic[12] methods. The results indicated two types of complexes for the metal ions with stoichiometric ratios 1:1 and 1:2 (M:L).

The apparent stability constant β_n is determined from the results of the mol ratio[9], straight line[10], continuous variation[8] and limiting logarithmic[12] methods. The mean values of log β as well as the values of $\triangle G°$ are also given in Table I.

The metal chloride solutions (10^{-4} M) were titrated with 10^{-3} M AZM, AZSB or AZH in aqueous or ethanolic medium, and the conductance-molar ratio curves indicated the formation of 1:1 and 1:2 complexes. The complex formation appears to be accompanied by the liberation of the proton from the α–OH substituent as gathered from the increase of the electrical conductance when the reagent is added to the metal ion solution.

TABLE I

Values of λ_{max}, log β and $-\triangle G°$ for AZM, AZSB and AZH complexes

Complex	λ_{max} (nm)	log β_1	$-\triangle G°$ K cal/mole	log β_2	$-\triangle G°$ K cal/mole
Mn(II)–AZM	620	4·70	6·4	10·01	13·6
Fe(II)–AZM	630	4·60	6·3	10·40	14·2
Co(II)–AZM	630	5·20	7·1	10·40	14·2
Ni(II)–AZM	620	5·08	6·9	10·60	14·4
Cu(II)–AZM	620	4·70	6·4	10·04	13·7
Fe(II)–AZSB	700	5·02	6·8	9·10	12·4
Co(II)–AZSB	680	4·50	6·1	9·10	12·4
Ni(II)–AZSB	650	5·20	7·1	9·80	13·4
Cu(II)–AZSB	690	4·90	6·6	9·30	12·6
Co(II)–AZH	425, 590	4·80	6·5	9·40	12·8
Ni(II)–AZH	425, 590	4·70	6·4	9·30	12·7
Cu(II)–AZH	400, 600	5·01	6·0	9·5	12·9