SPACED RECEIVER OBSERVATIONS OF JOVIAN DECAMETER FLUX

PROGRESS REPORT III

Status of Work as of Termination of

SC-NsG-407

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Under support of this grant a third flux monitering station was set up some 60km from the main station. The addition of this third station to the two already operating led to confirmation of the velocity of the interplanetary electron clouds responsible for the second long L-pulses -- some hundreds of km. 1 sec. --, has led to a study of the direction of this motion, and will allow the calculation of the shape of the irregularities in the interplanetary medium.

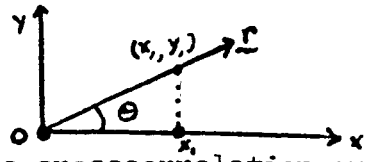
If the irregularities causing the L-pulses are either spherical in shape or arbitrary shapes randomly oriented such that their average electron density drops off uniformly in all directions, the spacial autocorrelation of density results in circular correlation contours in the plane containing the irregularities. Phase variation in radiation passing through this medium results in amplitude variations in the radiation received on earth from Jupiter. In the case outlined, delays in reception of the L-pulses at separated receivers together with auto and cross correlations of amplitude can be used to determine the velocity of the motion of the clouds. If the correlation contours take a more general form then a more complete reduction must be carried out. The reduction will first determine the average shape of the irregularities.

In order to obtain the correlation graphs it is necessary to digitize the analog records at each of the observing stations. As can be imagined, this is a tedious and laborious operation. Many of the two station records with good signal to noise ratio have been digitized and used to obtain accurate time lag data. A few of the early three station records have proven suitable for complete analysis and such analysis was begun under the current grant.

As a basis for first analysis we treat the contours of correlation as circular. This, as was explained, is equivalent to a medium of circular or randomly oriented irregularities. We observe the amplitude of radiation received at each of three stations. After digitizing the records by hand and eye the 7090-7094 of the Yale Computer Center was used to calculate autocorrelation of amplitude in time for each station and to calculate cross correlation between the flux amplitudes received at the observing stations in the usual way. If the medium is stable over the observing period a variation of amplitude in time at one observing site is equivalent to a variation of amplitude in distance along the line followed by the drifting medium. We verify the assumption of stability by comparing the autocorrelations derived from observations at the spaced sites. Minor variations are reduced by taking mean values to form a mean autocorrelation function which is then used in subsequent analysis.

Consider the geometry of the situation. We are observing the drift of an amplitude pattern over the ground. If one observing station is taken as the origin, the other to define X_1, and if the amplitude pattern drifts along a vector $\underset{\sim}{r}$ which reflects the drift of the medium, the maximum correlation between records will occur when that portion of the pattern which is initially at the origin is at

point X_1, Y_1 at some later time. We call this time lag Δt. This value



is derived from the crosscorrelation graphs. It can be crudely estimated by eye from the analog records. If the pattern has velocity v along the station axis then $X_1 = v\Delta t$. From the mean autocorrelation graph we find the time T which corresponds to the maximum value of cross-correlation $\rho_{max\text{-}cross} = \rho_{auto}(T)$.

As our correlation pattern is circular a cut along the r axis given by the autocorrelation graph is equivalent to a cut along any other axis -- in particular -- along Y thus

$$Y_1 = vT$$

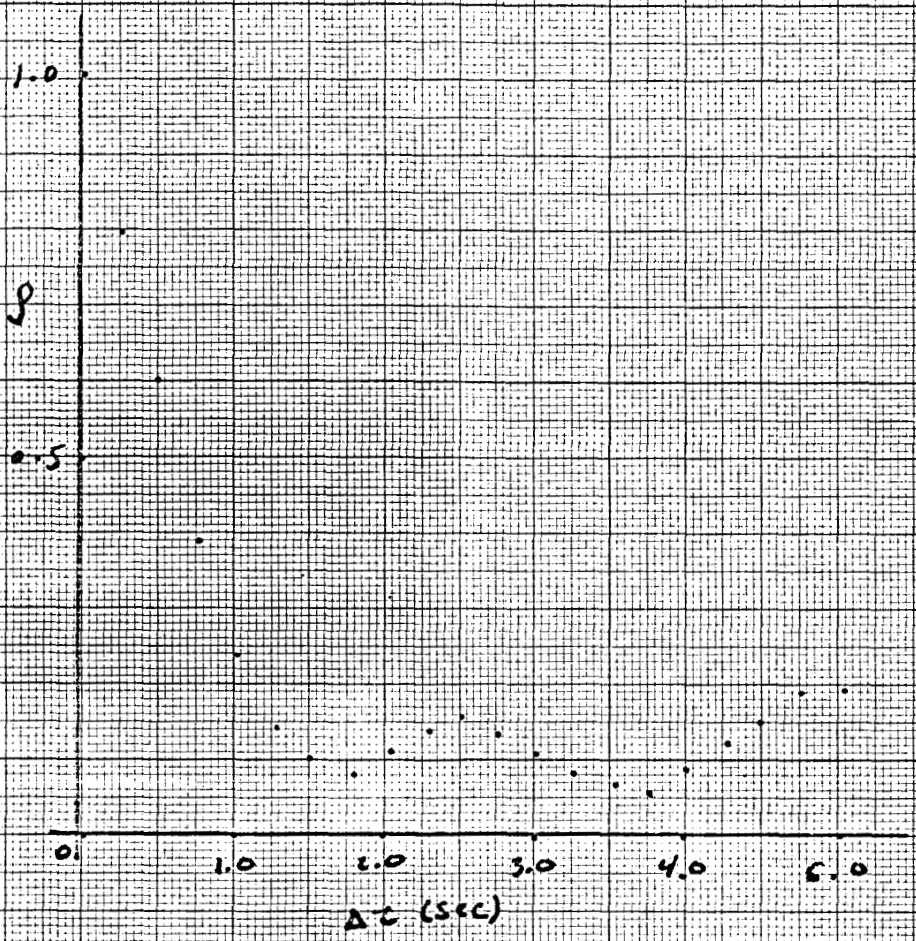
it is simple algebra to see

$$\mathrm{TAN}\theta = T/\Delta t$$

and as $90° \geq \theta$ we have $|\theta|$. The data from the third station removes the ambiguity of sign. With the value θ known we can determine the true velocity in the observing plane of the motion of the correlation pattern.

Results for the event of 23 October 1965 are presented in detail.

We note that for each set of data there are two possible velocity directions due to the ambiguity of sign. The third station eliminates the ambiguity and we see that one of each of these three pairs agree well. It will be noted that they indicate motion outward along the projection of the ecliptic. This is consistent with true motion in space radially outward from the sun.



MEAN AUTOCORRELATION DATA OF

23 OCT 65 0358 EST

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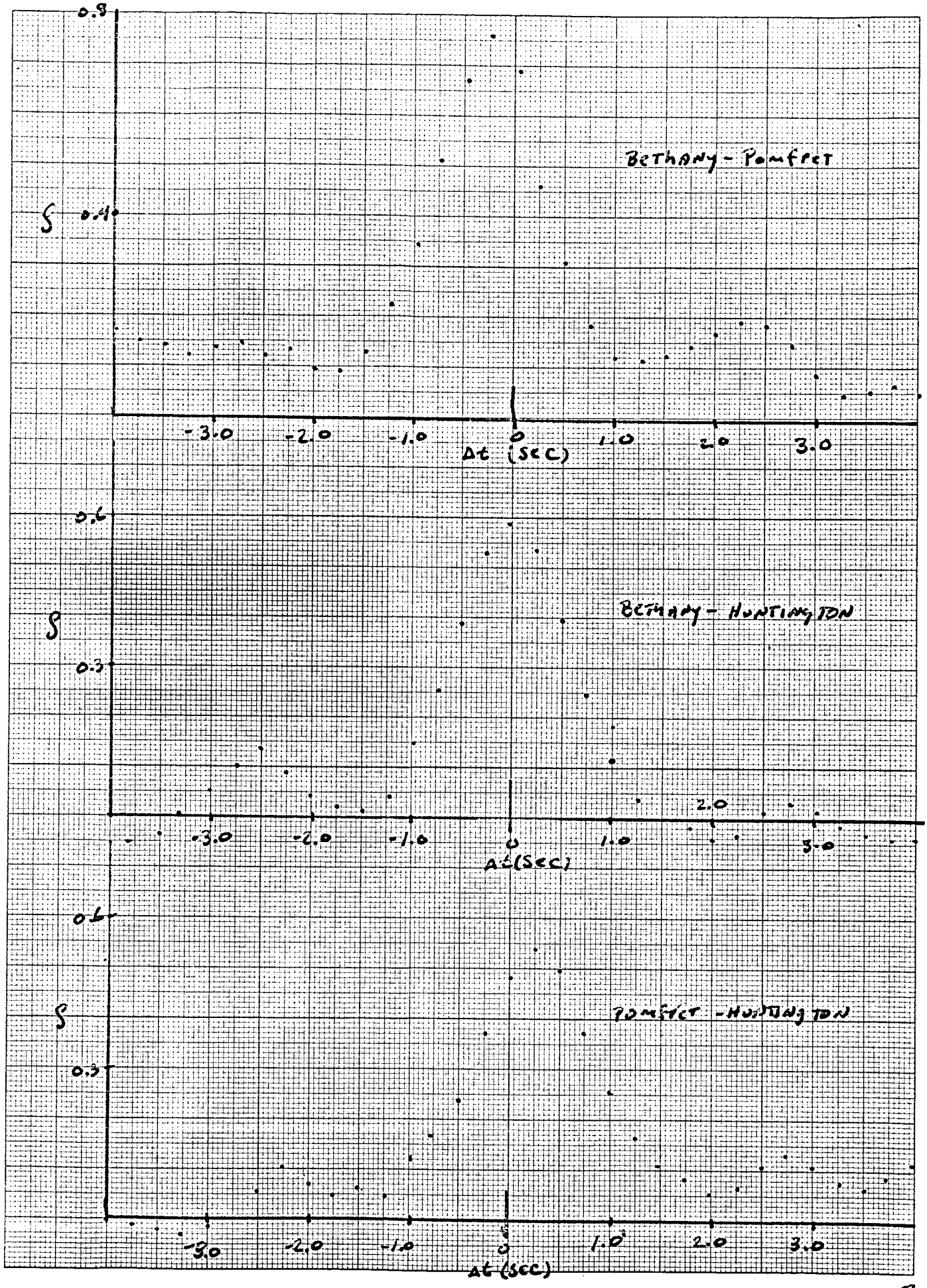

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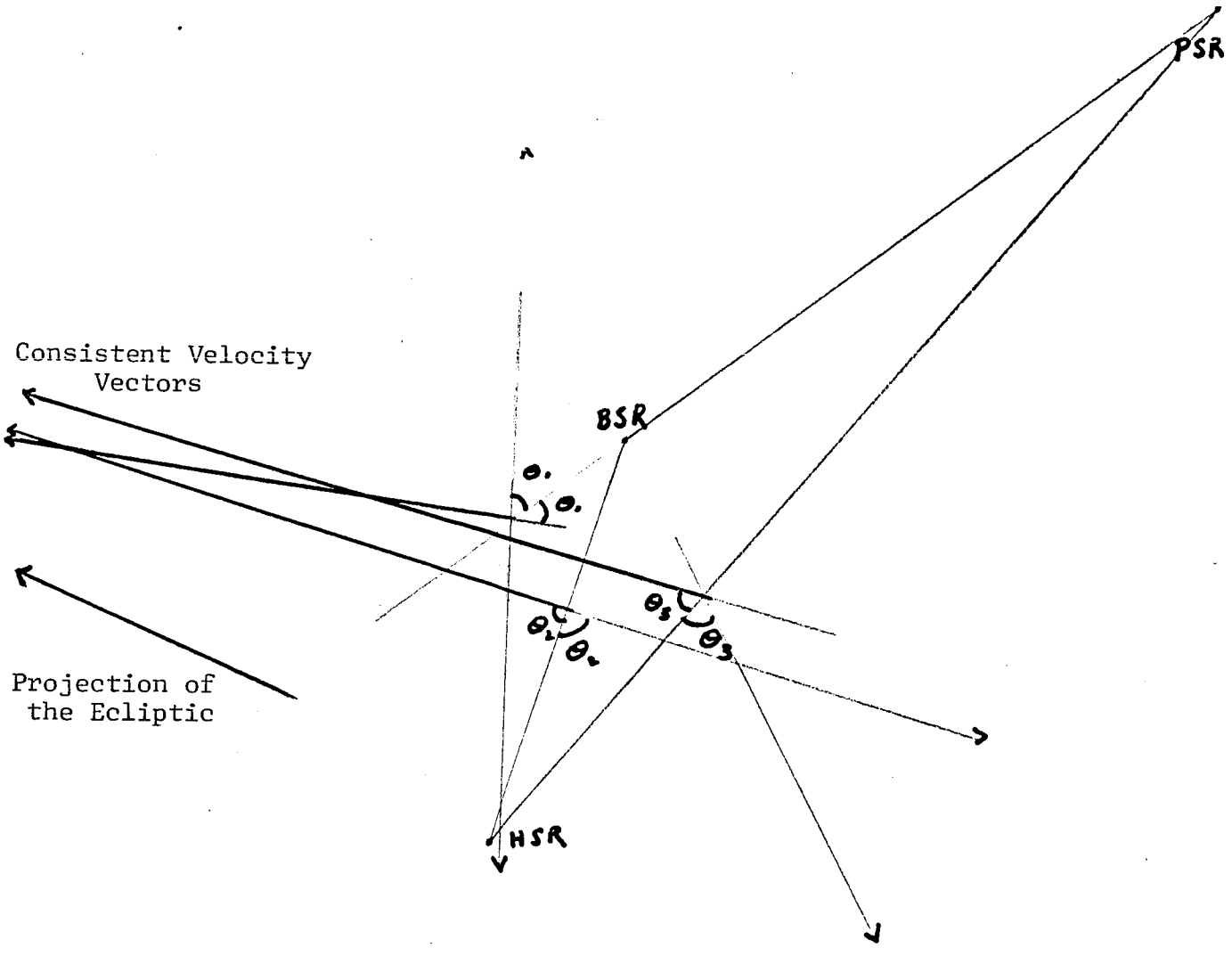
TABLE

Directions of the Velocity Vector in the Plane
Perpendicular to the Line of Sight to Jupiter
-23 October 65-

	Bethany-Pomfret	Bethany-Huntington	Pomfret-Huntington
Δt	$-0^{s}.24$	$0^{s}.0$	$+0^{s}.25$
ρ_{max}	0.77	0.58	0.54
T	$\pm 0^{s}.25$	$\pm 0^{s}.50$	$\pm 0^{s}.55$
$T/\Delta t$	±1.0416	$\pm\infty$	±2.2000
θ	±46°.2	±90°.0	±65°.6



The consistency of the three station work is a check on our assumptions. The autocorrelation functions were closely similar. This is a check on the time stability of the medium. The velocities obtained were in close agreement. This indicates that even in the correlation contours are elliptical and not strictly circular their motion is not such as would give a misleading projected velocity between two stations.

From this point we will move on to a more general examination of the three station records. An extension of the theory derived for ionospheric work and its casting in a form suitable for computer work is under way. This will allow calculation of the shape of the correlation contours and thus of the mean shape of the irregularities in the interplanetary medium. Records now in hand are being digitized for this use. Their analysis will give us data at various values of hour angle and Jovian longitude thus allowing a careful study of the interaction of the L-pulse phenomena with other astronomical parameters.