MIT Voyager Memo No. 29

To: Voyager Internal

From: A. Lazarus

Date: January 25, 1978

Subject: Relative cup transparencies.

This note describes a procedure for finding the relative cup transparencies which can then be used to correct the density calculations. The following calculations transform the solar wind velocity (given in "sensor" coordinates) to coordinate systems natural for each cup; find the flow angles realtive to the grid normal; and compute the transparency using optical grid transparencies. Nominal sensor orientations are used but the analysis herein can accept the correct orientations and can be modified to use more sophisticated transparencies.

The measured velocities are given in "sensor" coordinates as defined in Fig. 1. For any cup, we then define a "cup" coordinate system x_k, y_k, z_k, and normal n_k as follows

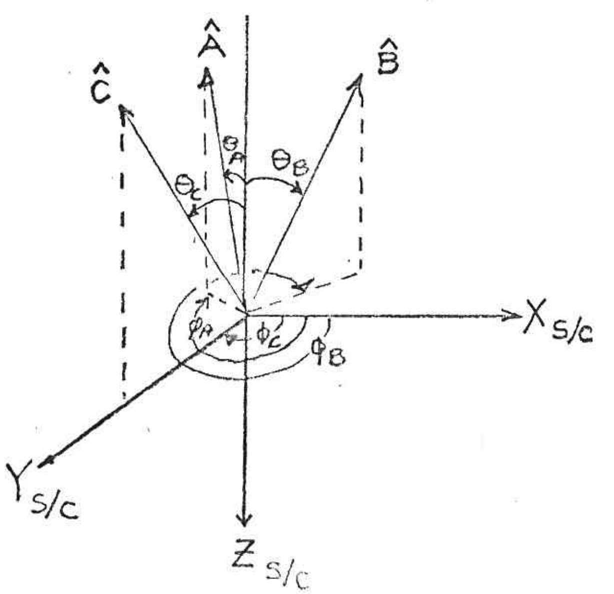


Fig.1- Sensor Coordinates

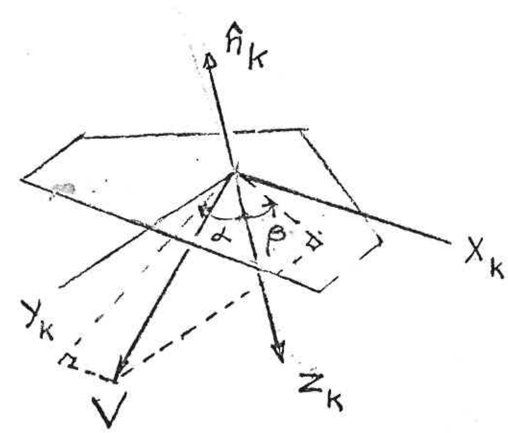


Fig.2- Cup Coordinates

The steps we need to take are

1) find the rotation matrix giving V_{x_k}, V_{y_k}, V_{z_k} in terms of V_x, V_y, V_z (which are the wind velocity components in sensor coordinates);

2) knowing the cup velocity components, we can then calculate the cup transparency and then

3) correct the density measured by that cup.

Step 1

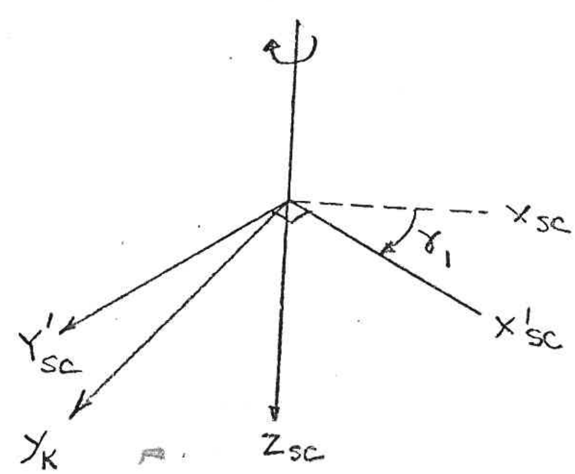
Use the Euler angle transformations as follows:

i) Rotate about z until x-axis is parallel to cup x-axis, x_k;

ii) rotate about new x-axis until new z-axis is in z_k, x_k plane;

iii) rotate about new y-axis until z-axes coincide.

i):



$$x' = x \cos \gamma_1 + y \sin \gamma_1$$

$$y' = -x \sin \gamma_1 + y \cos \gamma_1$$

$$z' = z$$

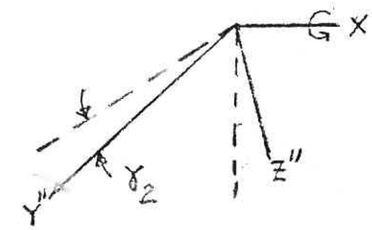
$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = M_1 \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

$$\therefore M_1 = \begin{pmatrix} \cos \gamma_1 & \sin \gamma_1 & 0 \\ -\sin \gamma_1 & \cos \gamma_1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

ii) $x'' = x$

$y'' = y' \cos \gamma_2 + z' \sin \gamma_2$

$z'' = -y \sin \gamma_2 + z' \cos \gamma_2$

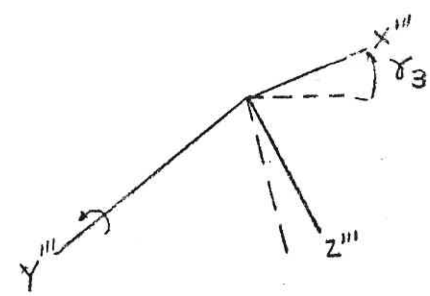


$$\therefore M_2 = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \gamma_2 & + \sin \gamma_2 \\ 0 & -\sin \gamma_2 & \cos \gamma_2 \end{pmatrix}$$

iii) $x''' = x'' \cos \gamma_3 - z'' \sin \gamma_3$

$y''' = y''$

$z''' = z'' \sin \gamma_3 + z'' \cos \gamma_3$



$$M_2 = \begin{pmatrix} \cos \gamma_3 & 0 & -\sin \gamma_3 \\ 0 & 1 & 0 \\ \sin \gamma_3 & 0 & \cos \gamma_3 \end{pmatrix}$$

The overall transformation is $M_3 M_2 M_1 = AM$

$$AM = \begin{pmatrix} \cos\gamma_3 \cos\gamma_1 - \sin\gamma_3 \sin\gamma_2 \sin\gamma_1 & \cos\gamma_3 \sin\gamma_1 + \sin\gamma_3 \sin\gamma_2 \cos\gamma_1 & -\sin\gamma_3 \cos\gamma_2 \\ \sin \gamma_2 \quad \sin \gamma_1 & \cos \gamma_2 \quad \cos \gamma_1 & \sin \gamma_2 \\ \sin\gamma_3 \cos\gamma_1 + \cos\gamma_3 \sin\gamma_2 \sin\gamma_1 & \sin\gamma_3 \sin\gamma_1 - \cos\gamma_3 \sin\gamma_2 \cos\gamma_1 & \cos\gamma_3 \cos\gamma_2 \end{pmatrix}$$

Parameters for the sensors (ref. Voyager Memo. No. 20): Note that the axes are not the same* The axes in this memo are the same as used in the analysis program .

Sensor	γ_1	γ_2	γ_3	
A	+120.7°/+120.7°	19.99°/20.3°	?	.../...=
B	-119.6°/-121.2°	200.0°/19.76°	?	Voyager 1/2
C	-.3°/ -.56°	19.47°/19.5°	?	

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* $\phi = 90° - \phi_{old}$

$\therefore \gamma_1 = \quad - 90° = - \phi_{old}$; $\gamma_2 = \theta_{old}$

Using the nominal values,

$$AM = \left\{ \begin{matrix} \begin{pmatrix} -.5 \\ -.5 \\ +1 \end{pmatrix} & \begin{pmatrix} .866 \\ -.866 \\ 0 \end{pmatrix} & 0 \\ \begin{pmatrix} -.813 \\ +.813 \\ 0 \end{pmatrix} & \begin{pmatrix} -.470 \\ -.470 \\ .940 \end{pmatrix} & .342 \\ \begin{pmatrix} .269 \\ -.269 \\ 0 \end{pmatrix} & \begin{pmatrix} -.171 \\ -.171 \\ +.342 \end{pmatrix} & .940 \end{matrix} \right\} \quad \text{and} \quad \begin{pmatrix} \cdot \\ \cdot \\ \cdot \end{pmatrix} = \begin{pmatrix} \text{cup A} \\ \text{cup B} \\ \text{cup C} \end{pmatrix}$$

Step 2

Transform the solar wind velocity components.

$$\begin{pmatrix} V_{x_j} \\ V_{y_j} \\ V_{z_j} \end{pmatrix} = AM \begin{pmatrix} V_x \\ V_y \\ V_z \end{pmatrix}$$

Now given the velocity in the cup frame find $\cos\alpha$ and $\cos\beta$ where

$$\cos\alpha = \frac{V_z}{\sqrt{V_z^2 + V_y^2}}$$

$$\cos\beta = \frac{V_z}{\sqrt{V_z^2 + V_x^2}}$$

then $T = \left(1 - \frac{d}{s\cos\beta}\right)\left(1 - \frac{d}{s\cos\alpha}\right)$

where d is the diameter of a grid wire and

s is the spacing between the wire centers

McNutt

Voyager Memo #31

To: Voyager Internal, Voyager External

From: G.S. Gordon, Jr.

Date: 2-15-78

Subject: Voyager Analysis Program: Input

Attached is the GSFC request form for running the voyager analysis program. It gives the definition of all current defined logical switches. In addition, the PLSMA code reads a name list "PLSNT" with the following variables.

&PLSNT

IDSRN(15) — PRINT debug output on logical unit IDSRN for
1 print mode on status charge
2 KNTCUR
3 MODCAL
4 IDCANL
5 CURCAL
6 STDANL
7 PRANL
8 ELANAL
9 GETFLED
10 BKGDCR
11 PLSBEG
12 VGRLOG
13 ANSPRT
14 spare
15 all errors

IPR(4,2)	# of channels above peak for proton moment estimate
IPQ(4,2)	# of channels below peak for proton moment estimate
IPQF(2,2)	# of channels above peak for alpha moment estimate
IPRF(2,2)	# of channels below peak for alpha moment estimate
ALPHA	$N\alpha/Np$ threshold to do α analyses
IENP	maximum # of calls to FNCDRV
EPS	wanted fractional error in x^2

&END