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SMR 1161/36

AUTUMN COLLEGE ON PLASMA PHYSICS

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Average Solar Wind

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Average Solar Wind

Properties at 1 A.U.

$V = 400\ km/s$ $\qquad n = 5\ cm^{-3}$

$T_p = 10^5 K$ $\qquad T_e = 2 \times 10^5 K$

$B_o = 5\ nT$ $\qquad \phi_p = A\tan(B\phi/B_r) = \pi/4$

$C_A = B_o/(4\pi n M)^{1/2} = 50\ km s^{-1}$

$C_i = (\gamma k T_i/M)^{1/2} = 37\ km s^{-1}$

$p_w = nMv^2 = 10^{-8}\ dyn\ cm^{-2}$

$p_i = nkT_i = 0.67 \times 10^{-10}\ dyn \cdot cm^{-2}$

$p_e = nkT_e = 1.33 \times 10^{-10}\ dyn\ cm^{-2}$

$p = p_i + p_e = 2 \times 10^{-10}\ dyn\ cm^{-2}$

$p_B = B_o^2/8\pi = 10^{-10}\ dyn\ cm^{-2}$

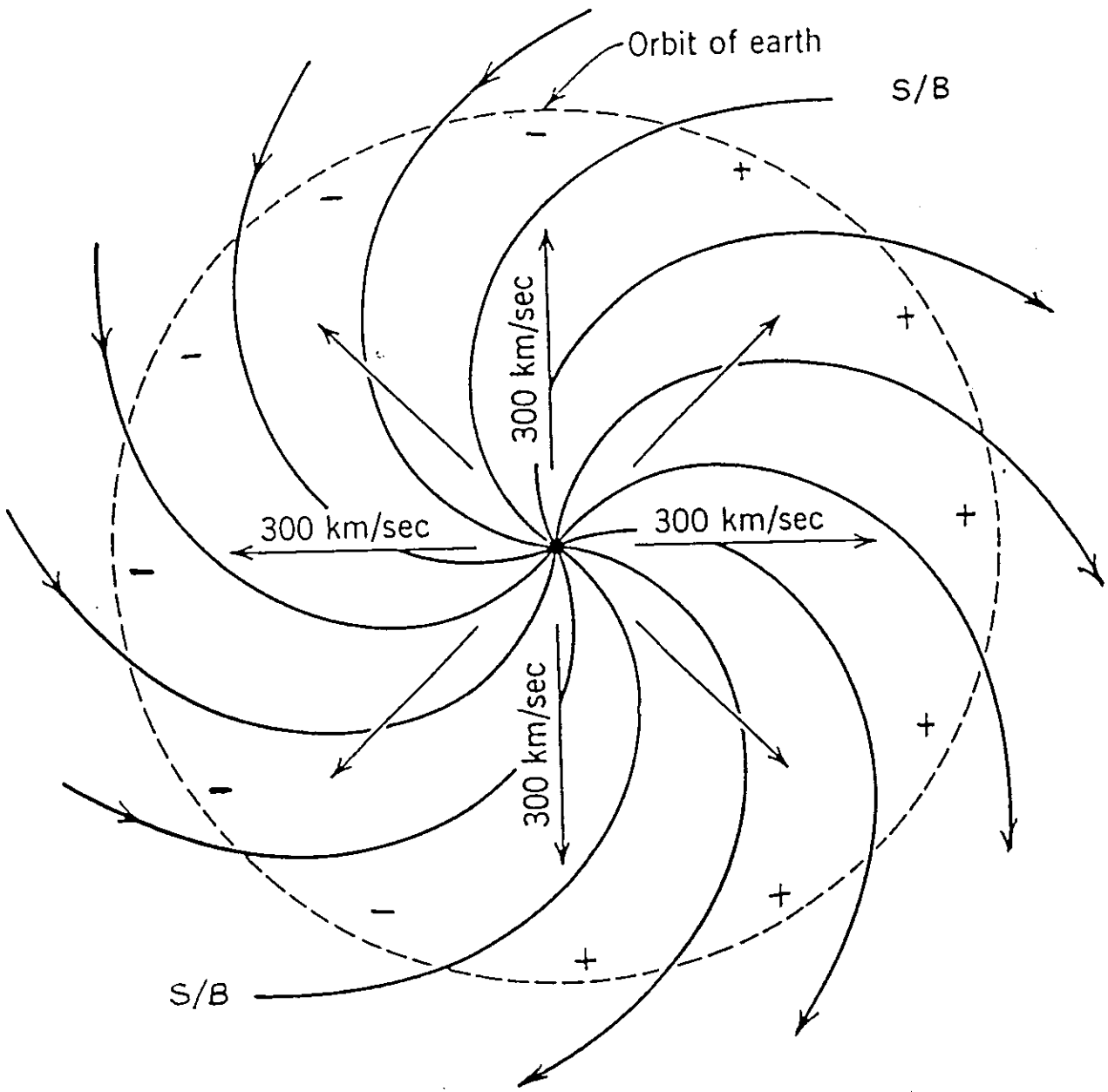
$\beta = p/p_B = 2$

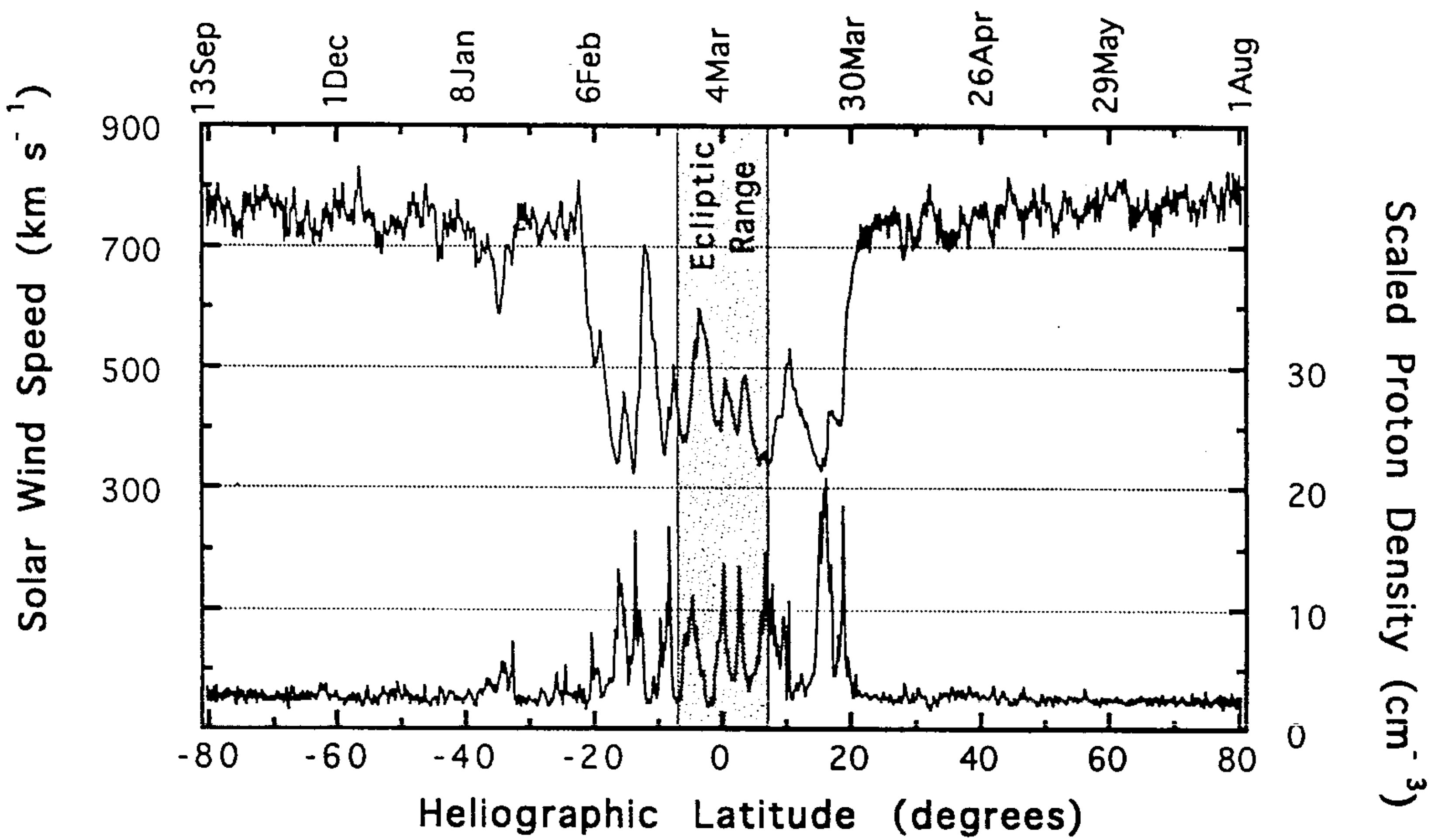
$B^2 = B_o^2 + (\delta B)^2 = 2B_o^2$

$\beta_w \simeq 1$

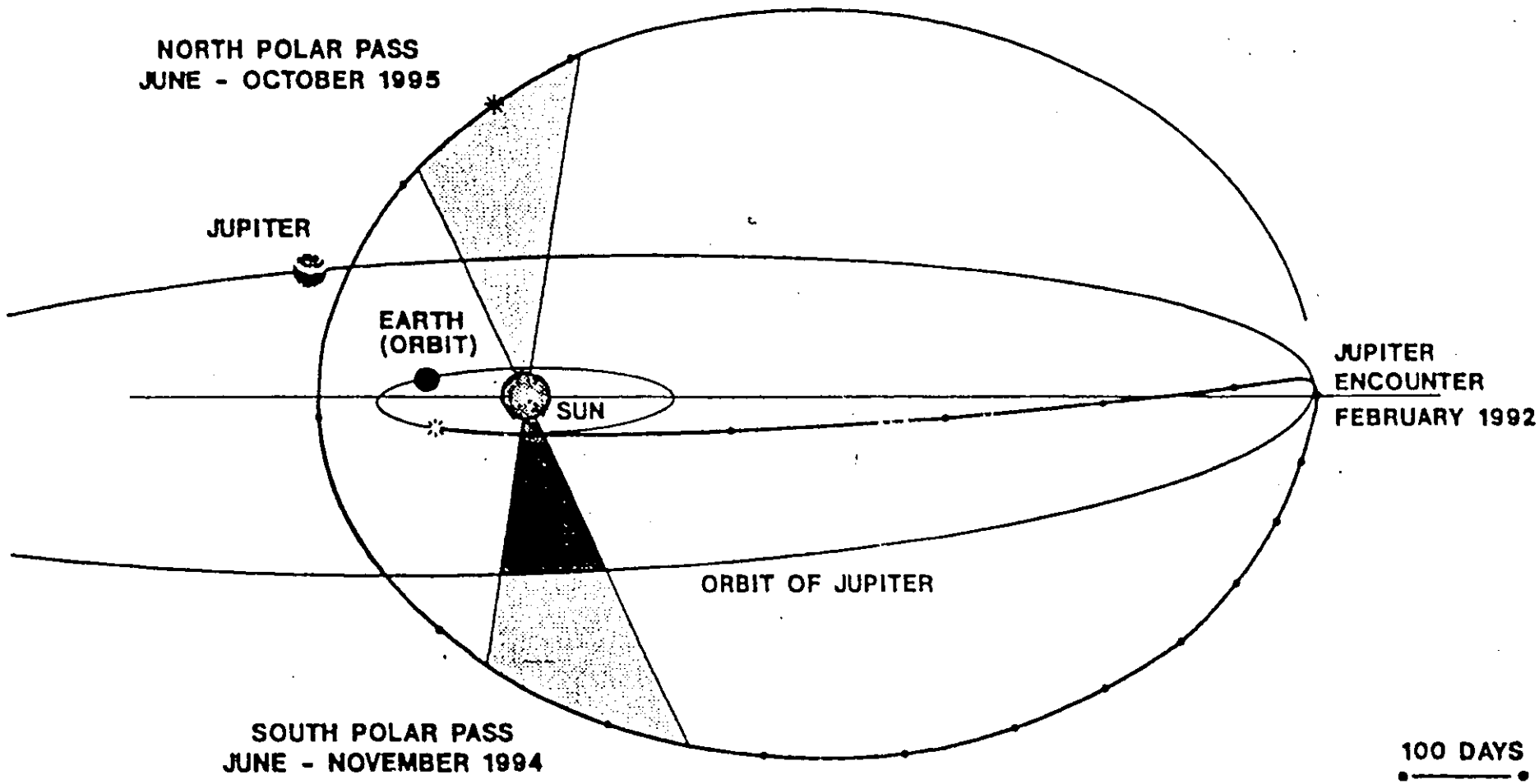
HELIOSPHERIC CONSTITUENTS OF SOLAR OR INTERNAL ORIGIN

- Solar wind
  - Protons, electrons, heavy ions
- Magnetic fields
- Plasma waves
- Solar radio waves
- Solar energetic particles
- Solar x-rays
- Energetic particles accelerated inside the heliosphere
  - Energetic storm particles
  - Anomalous cosmic rays
- Dust


Orbit of earth
S/B
300 km/sec
300 km/sec
300 km/sec
300 km/sec
S/B



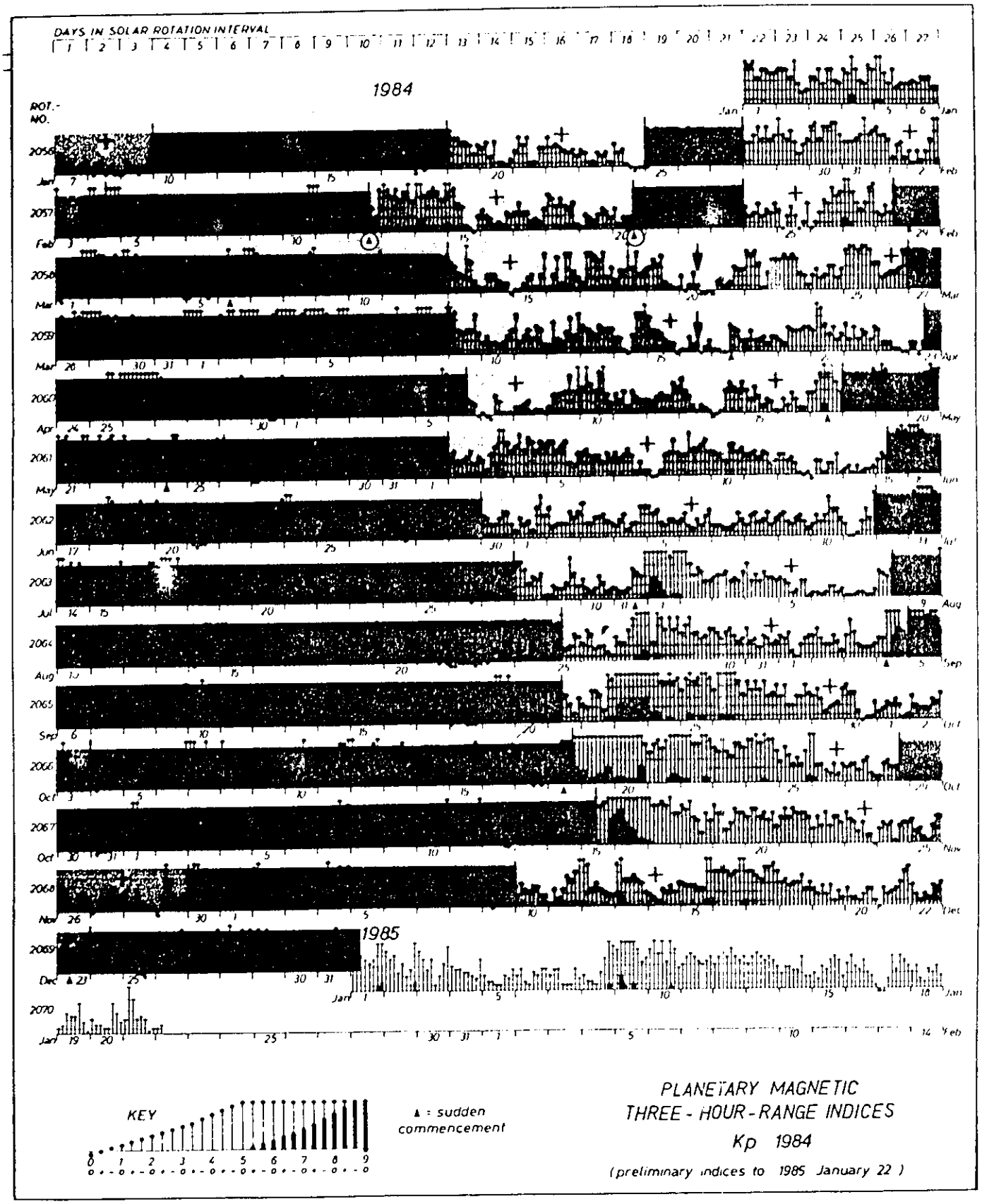
13Sep
1Dec
8Jan
6Feb
4Mar
30Mar
26Apr
29May
1Aug
Solar Wind Speed (km s^{-1})
900
700
500
300
Ecliptic Range
Scaled Proton Density (cm^{-3})
30
20
10
0
-80
-60
-40
-20
0
20
40
60
80
Heliographic Latitude (degrees)

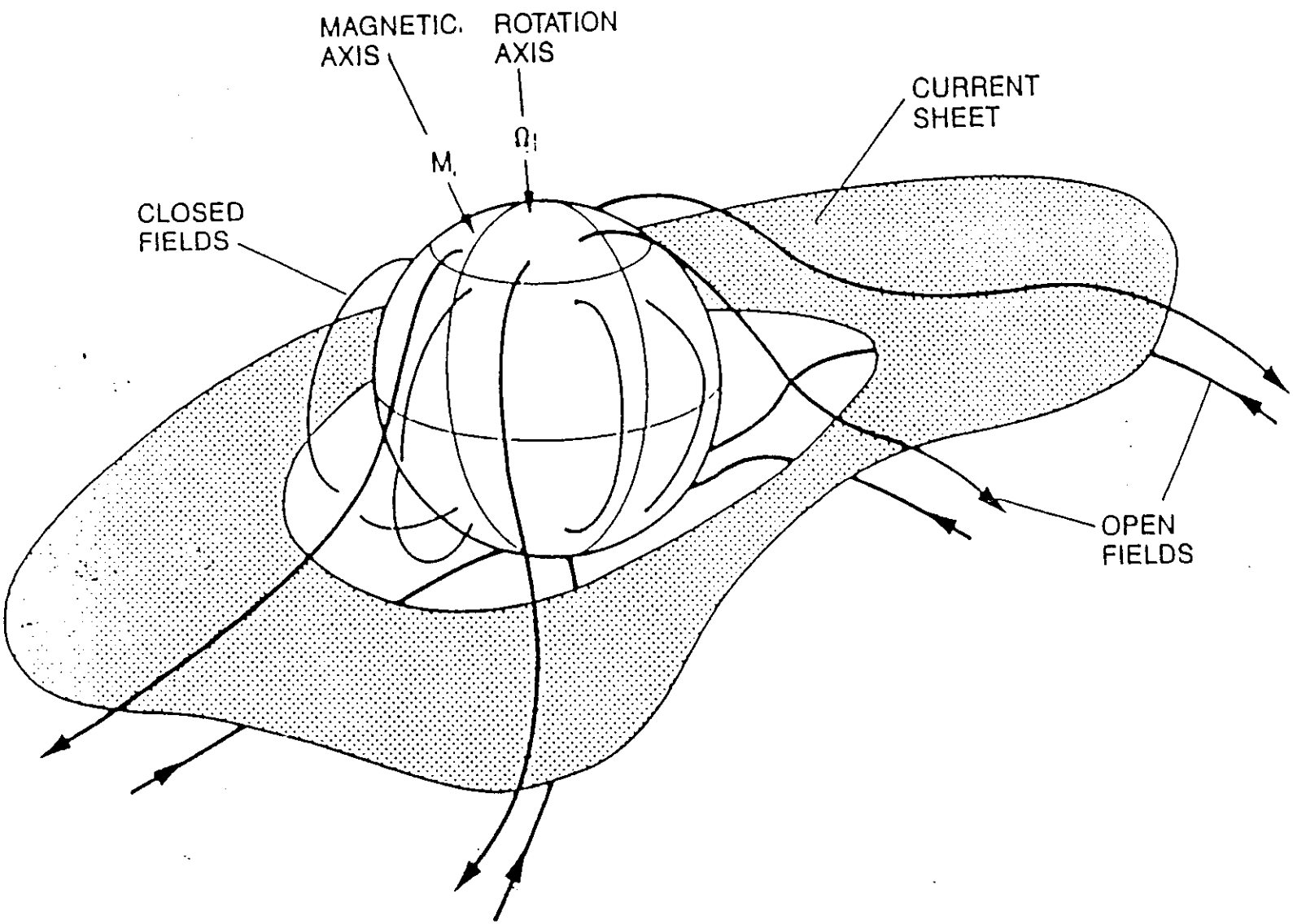

NORTH POLAR PASS
JUNE - OCTOBER 1995
JUPITER
EARTH
(ORBIT)
SUN
JUPITER
ENCOUNTER
FEBRUARY 1992
ORBIT OF JUPITER
SOUTH POLAR PASS
JUNE - NOVEMBER 1994
100 DAYS

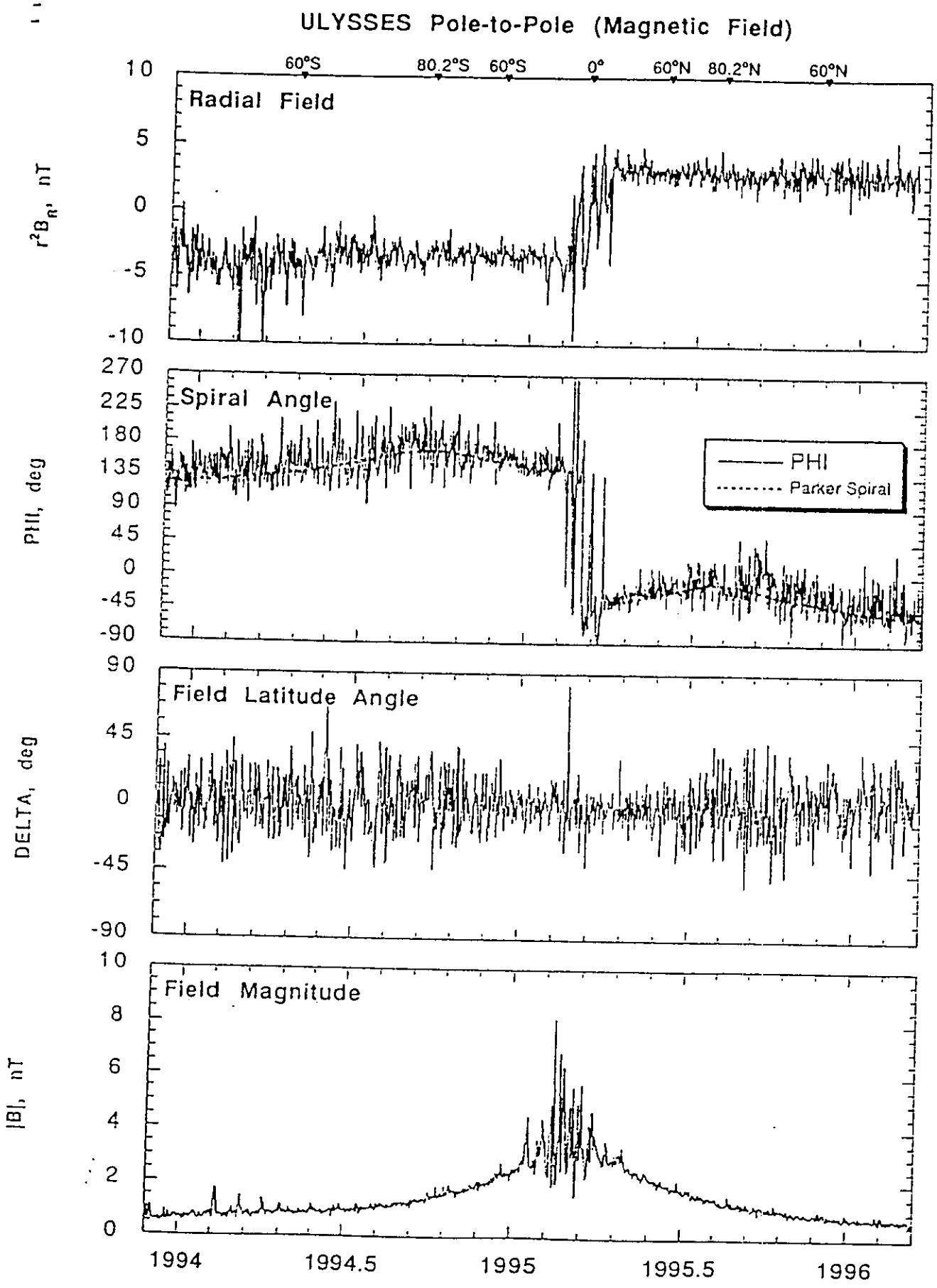
PLANETARY 3-HOUR-RANGE INDICES (Kp) BY 27-DAY SOLAR ROTATION INTERVAL

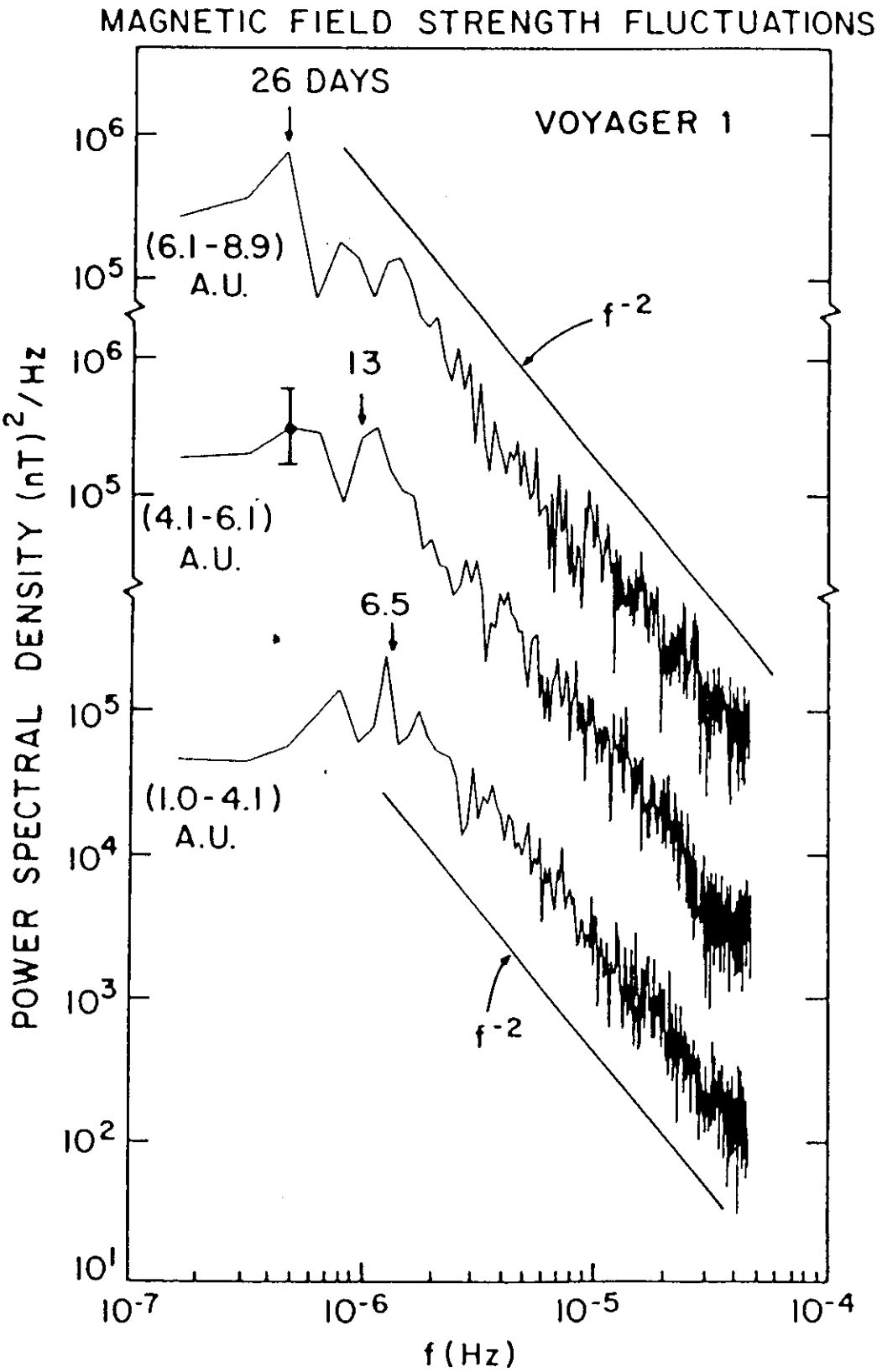
University of Gottingen

Kp through December 31, 1984




MAGNETIC AXIS
ROTATION AXIS
CURRENT SHEET
Ω_i
M_i
CLOSED FIELDS
OPEN FIELDS


ULYSSES Pole-to-Pole (Magnetic Field)
60°S
80.2°S
60°S
0°
60°N
80.2°N
60°N
Radial Field
r^2B_R, nT
10
5
0
-5
-10
Spiral Angle
PHI
Parker Spiral
PHI, deg
270
225
180
135
90
45
0
-45
-90
Field Latitude Angle
DELTA, deg
90
45
0
-45
-90
Field Magnitude
|B|, nT
10
8
6
4
2
0
1994
1994.5
1995
1995.5
1996


MAGNETIC FIELD STRENGTH FLUCTUATIONS
26 DAYS
VOYAGER 1
(6.1-8.9) A.U.
(4.1-6.1) A.U.
(1.0-4.1) A.U.
13
6.5
f^-2
f^-2
POWER SPECTRAL DENSITY (nT)^2/Hz
f (Hz)
10^6
10^5
10^6
10^5
10^5
10^4
10^3
10^2
10^1
10^-7
10^-6
10^-5
10^-4

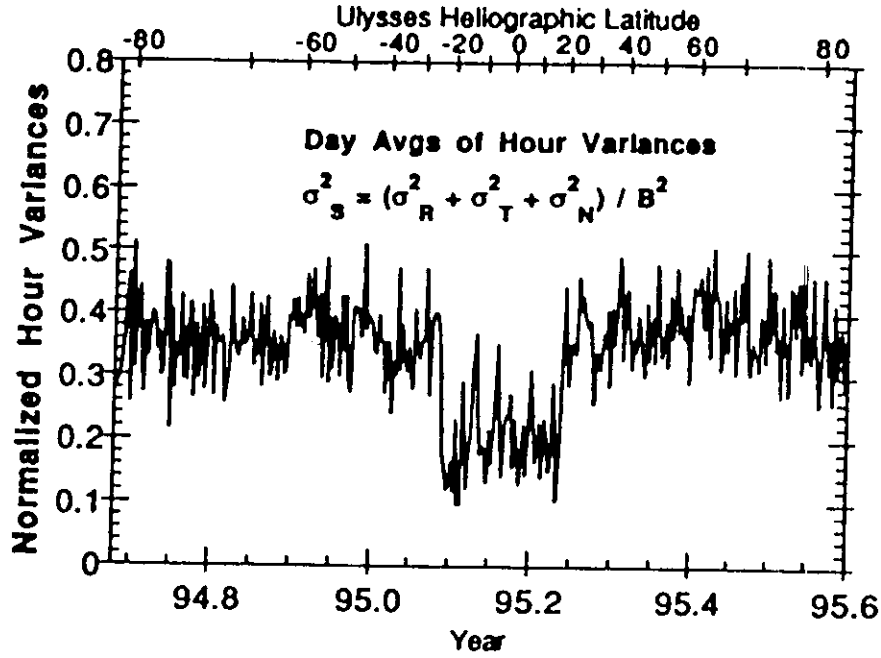


Figure 1

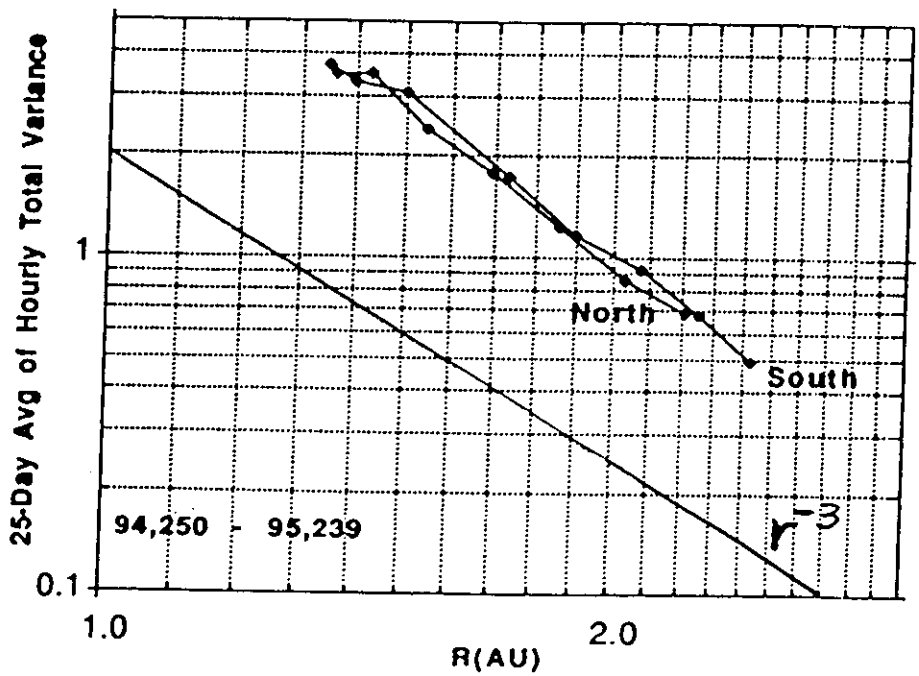
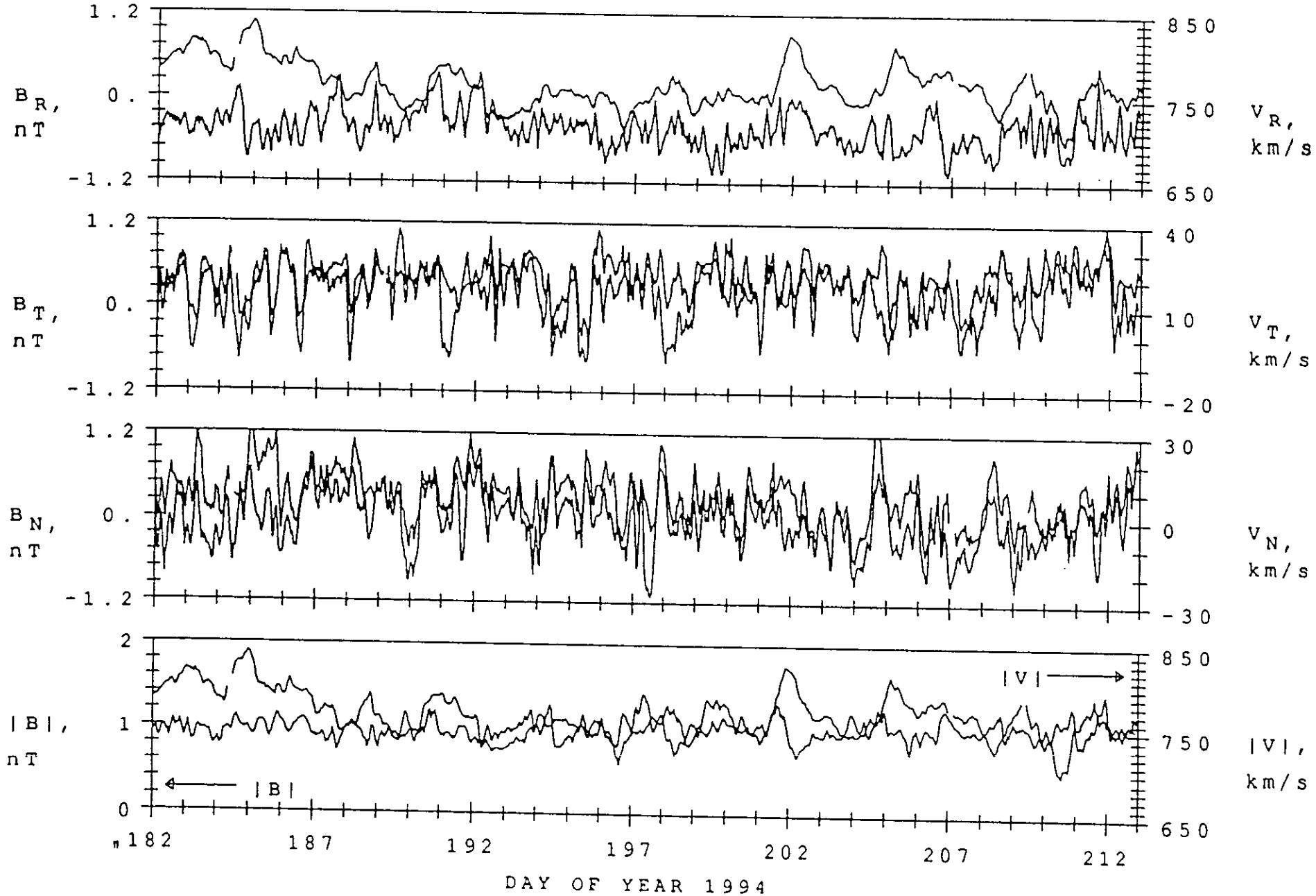


Figure 2

ULYS Hour Avgs SH Coords

Jul 1 - Jul 31, 1994 (182-212)



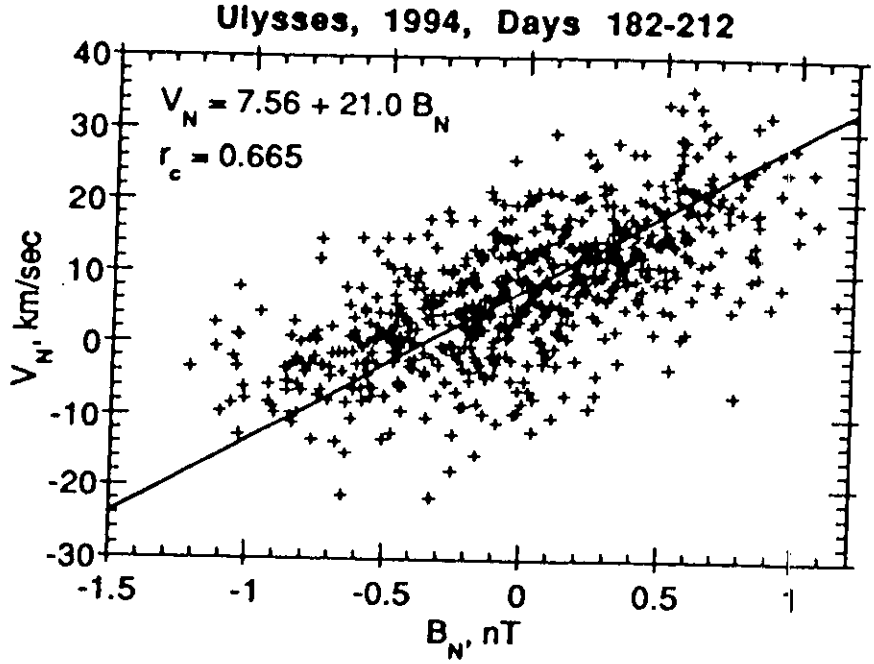


Figure 3

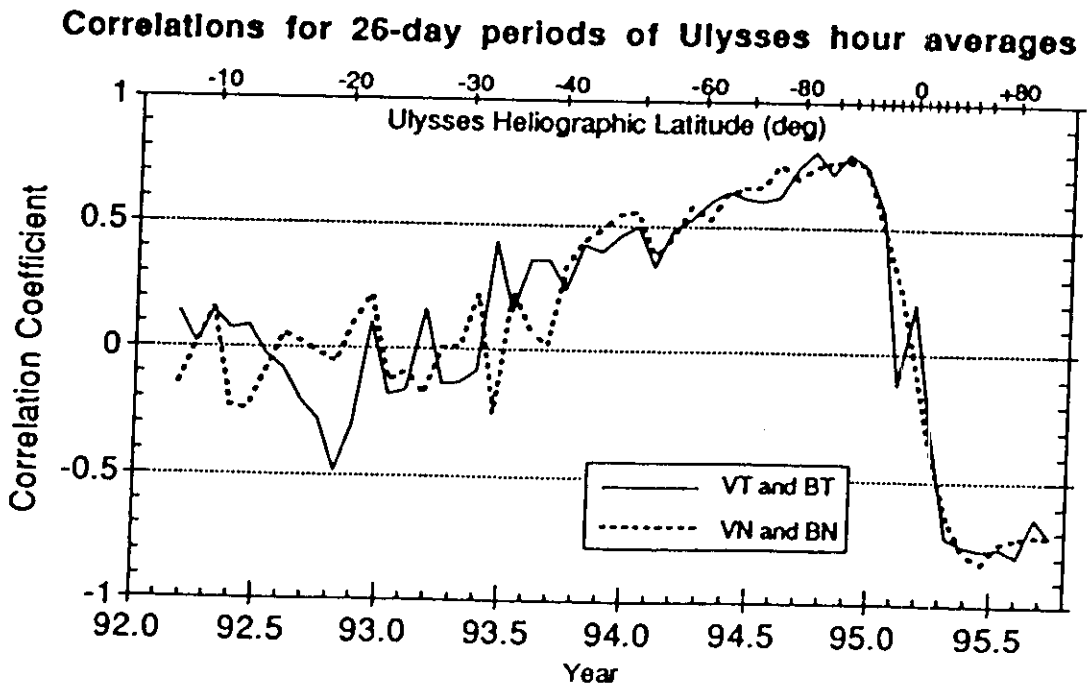
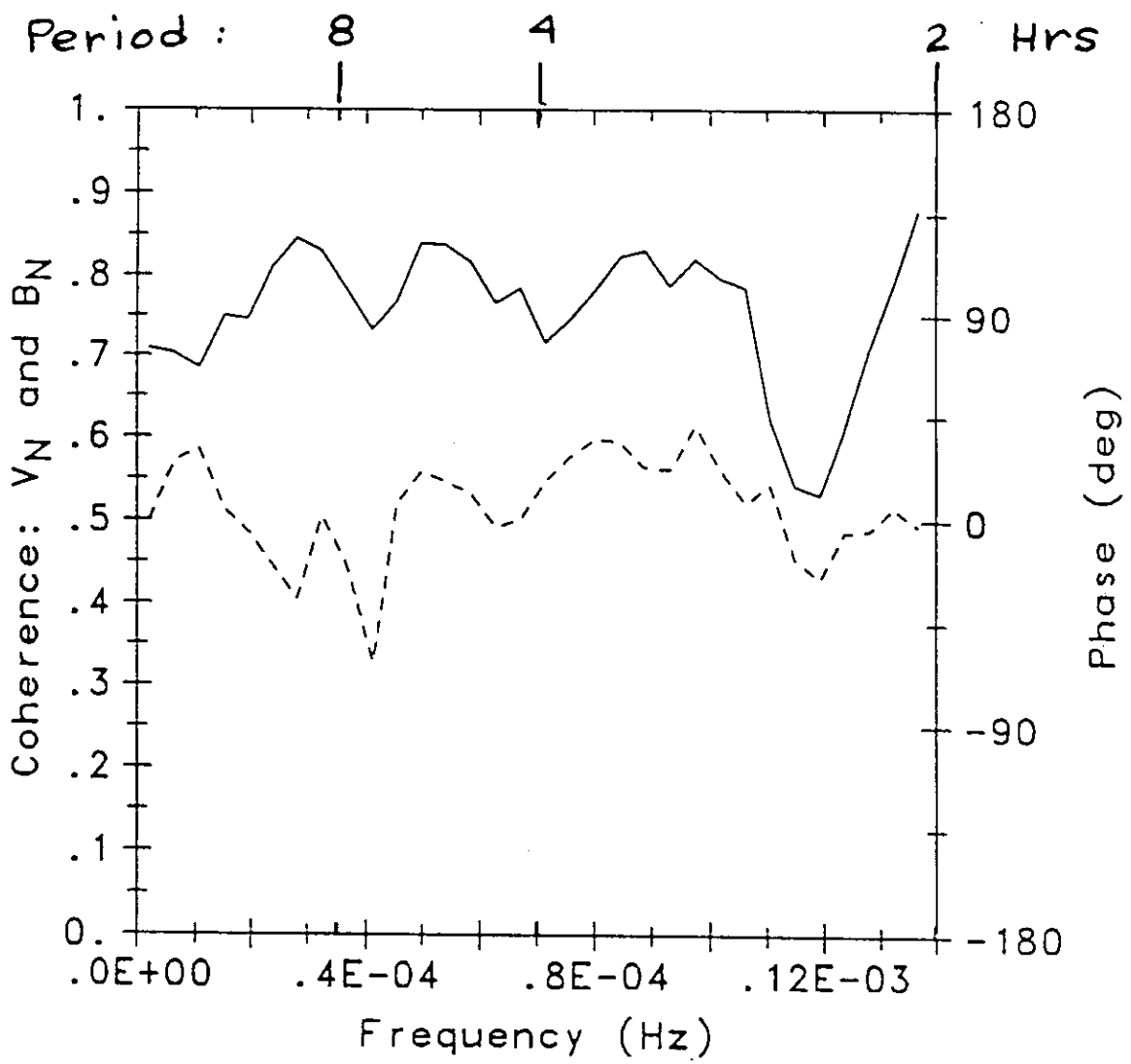


Figure 4


Period :
8
4
2
Hrs
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.
180
90
0
-90
-180
Coherence: V_N and B_N
Phase (deg)
.0E+00
.4E-04
.8E-04
.12E-03
Frequency (Hz)

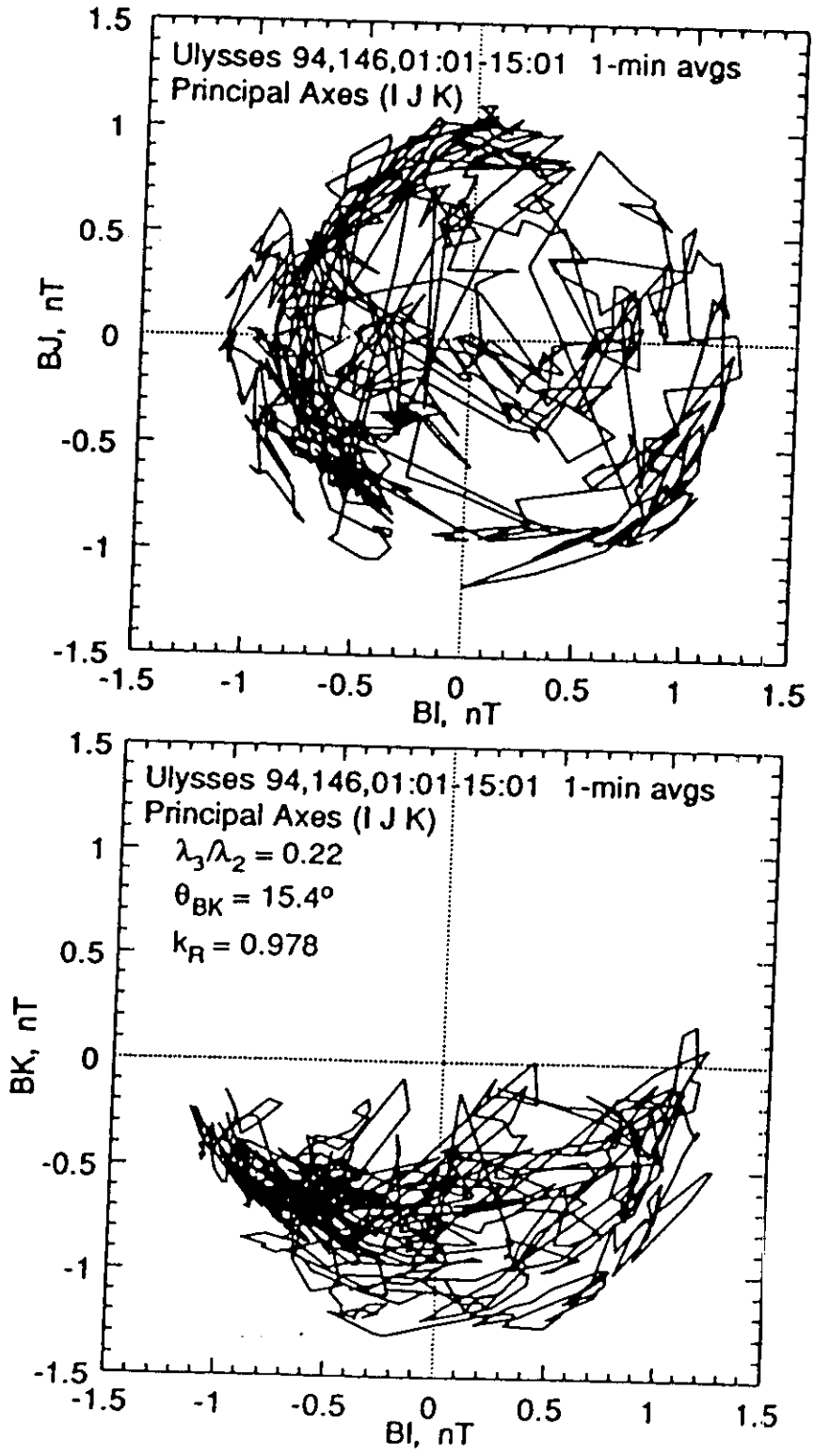

Ulysses 94,146,01:01-15:01 1-min avgs
Principal Axes (I J K)
BJ, nT
BI, nT
Ulysses 94,146,01:01-15:01 1-min avgs
Principal Axes (I J K)
$\lambda_3/\lambda_2 = 0.22$
$\theta_{BK} = 15.4°$
$k_R = 0.978$
BK, nT
BI, nT

Figure 5

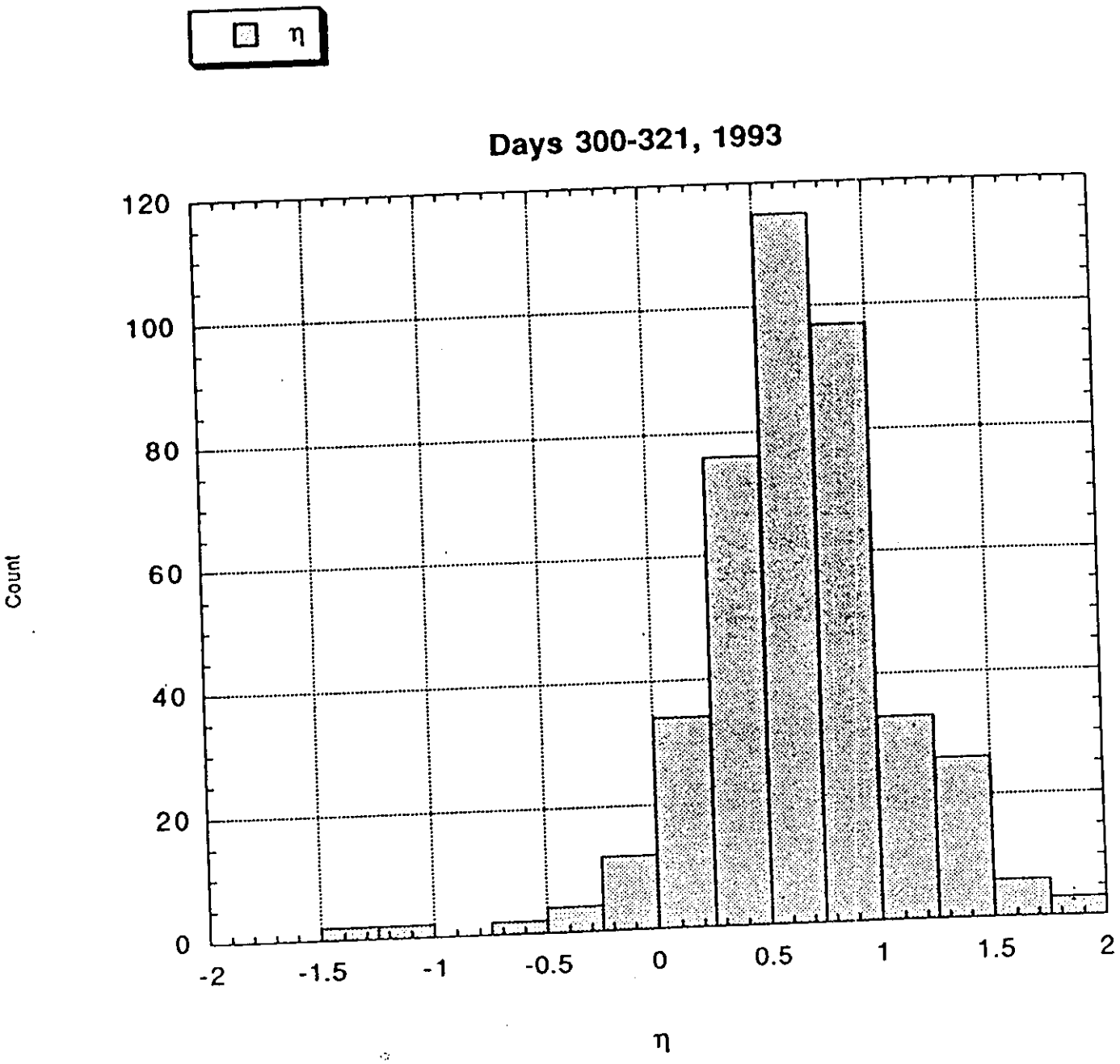
In presence of a pressure anisotropy

$$\frac{\delta \vec{V}}{\delta \vec{B}} = \pm (4\pi n M)^{-1/2} \eta^2$$

where $\eta = 1 - \frac{p_{\parallel} - p_{\perp}}{B^2/4\pi}$

$$\eta \geq 0 \quad \text{or} \quad \frac{p_{\parallel} - p_{\perp}}{B^2/4\pi} > 1$$

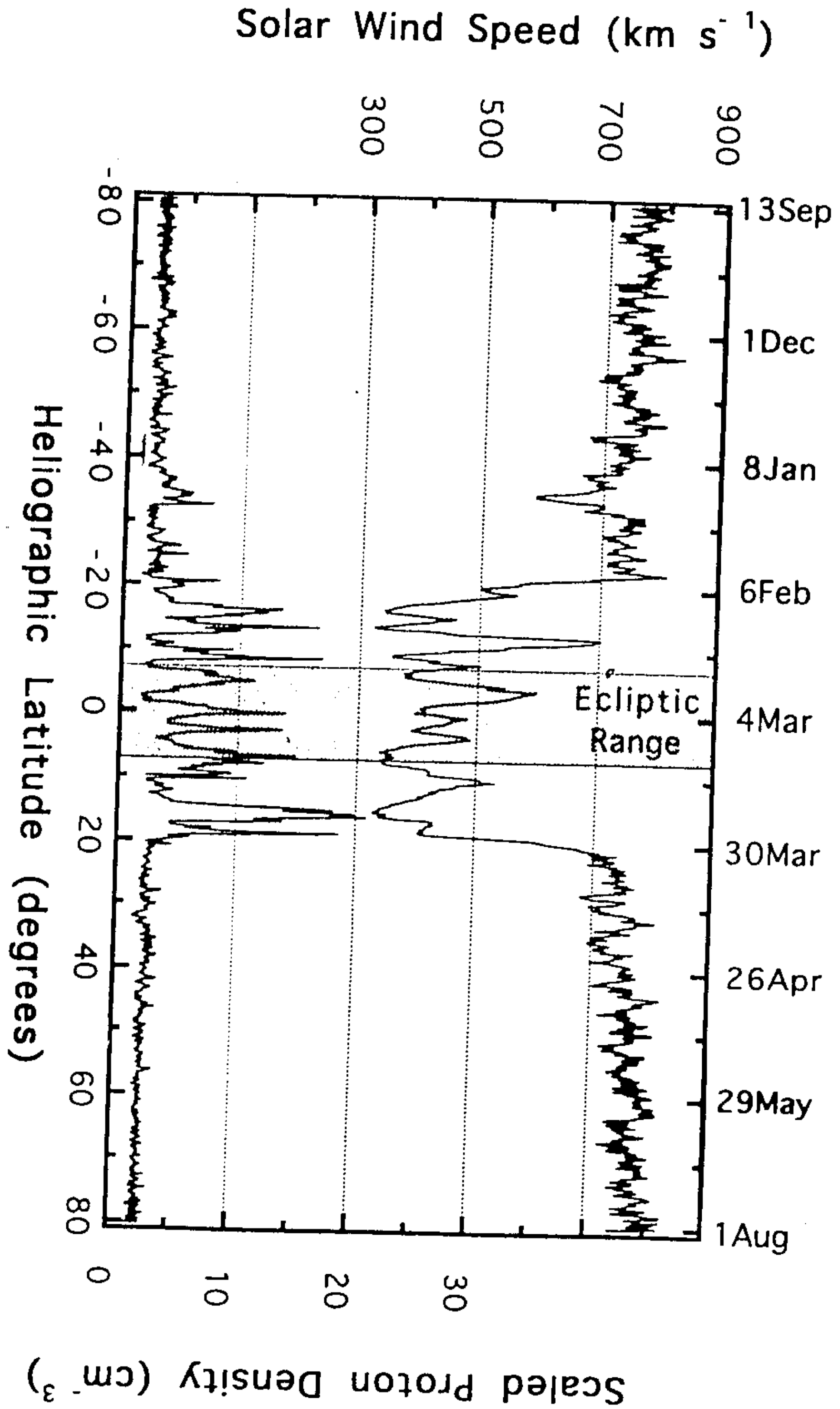
implies Firehose instability



$N = 424$ $\quad \langle \eta \rangle = 0.71$ $\quad \sigma/\sqrt{N} = .03$

$\sigma = 0.71$

$\hat{\eta} = 0.68$ (median)



Solar Wind Speed (km s⁻¹)
300
500
700
900
13Sep
1Dec
8Jan
6Feb
4Mar
30Mar
26Apr
29May
1Aug
Ecliptic Range
Heliographic Latitude (degrees)
-80
-60
-40
-20
0
20
40
60
80
0
10
20
30
Scaled Proton Density (cm⁻³)