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SPRING COLLEGE ON PLASMA PHYSICS

(25 May - 19 June 1987)

PLASMA PHYSICS PHENOMENA DETECTED AT COMET GIACOBINI-ZINNER

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Plasma Physics Phenomena Detected at Comet Giacobini-Zinner

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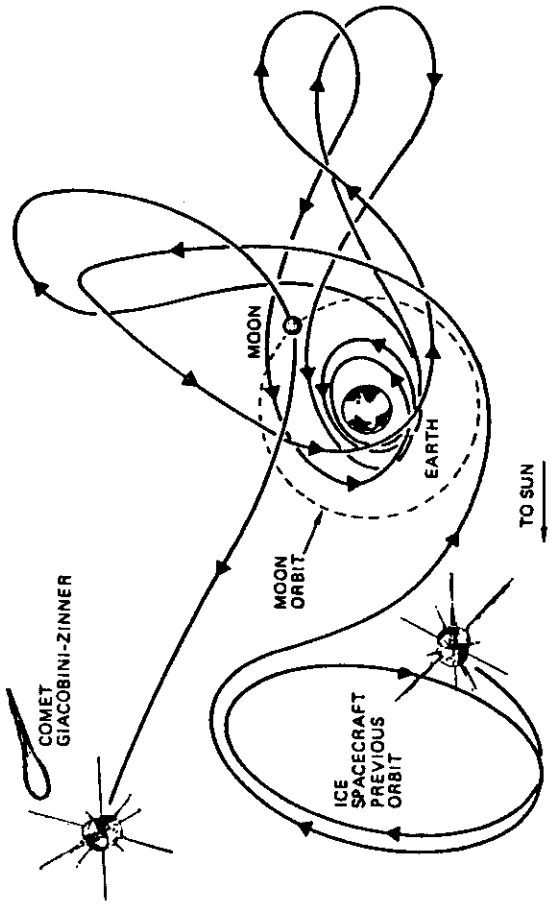
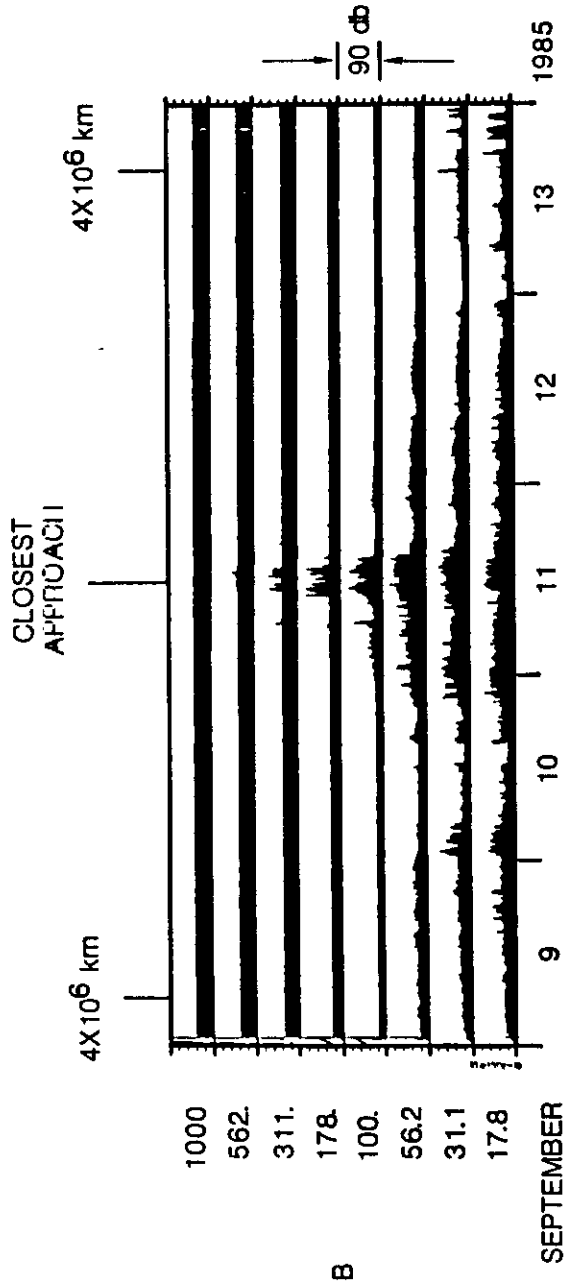
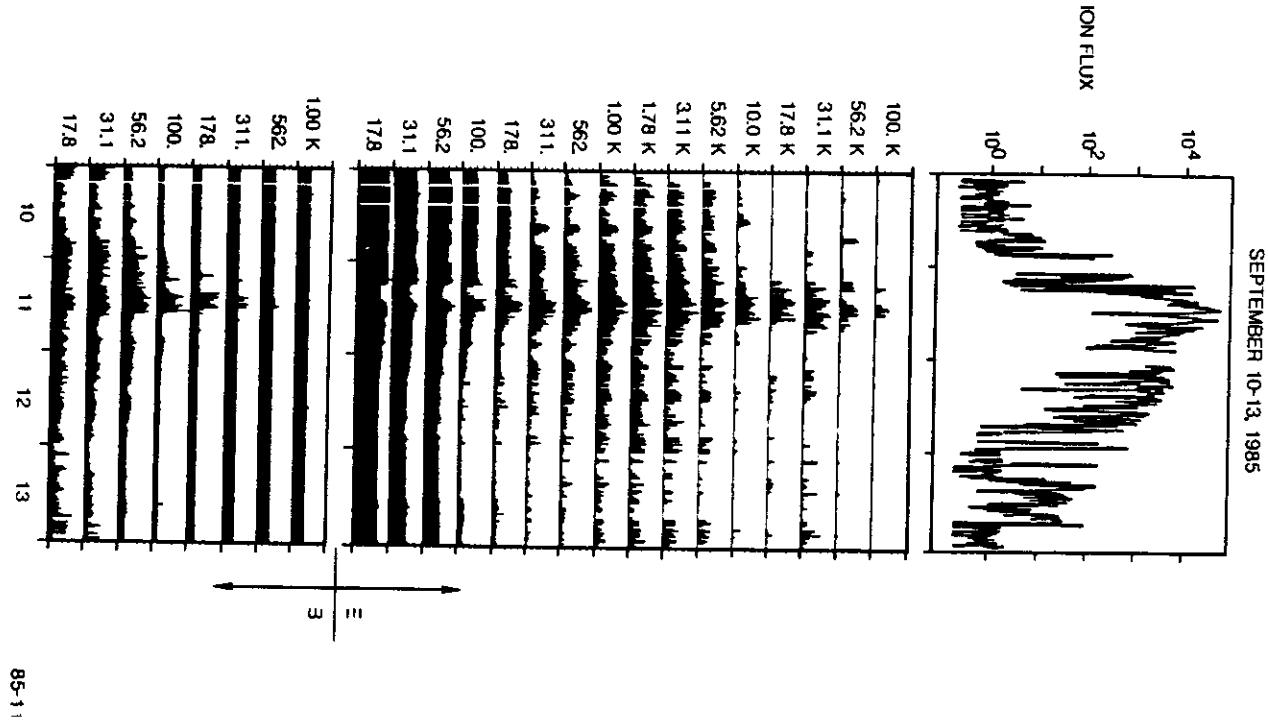
On September 11, 1985, the International Cometary Explorer (ICE) became the first spacecraft to encounter a comet when it traversed the tail of Giacobini-Zinner at a downstream distance of 7800 km. The spacecraft payload included instruments to measure the magnetic field (DC to 1 kHz), the low energy electron distribution functions (E < 1 keV), electric field wave phenomena (3 Hz to several MHz), ion composition (thermal and energetic ions), and energetic particle distributions in the range 30 keV to 500 keV. These instruments detected extremely strong interactions that extended over distance scales measured in millions of kilometers. Unique plasma physics phenomena were found to be very important at the comet. The comet interaction processes include pickup and energization of newly-born cometary ions at great distances, effects of mass loading on the solar wind-comet interaction, development of intense plasma turbulence and formation of a diffuse low-Mach number bow shock.



ICE SCIENTIFIC MEASUREMENTS

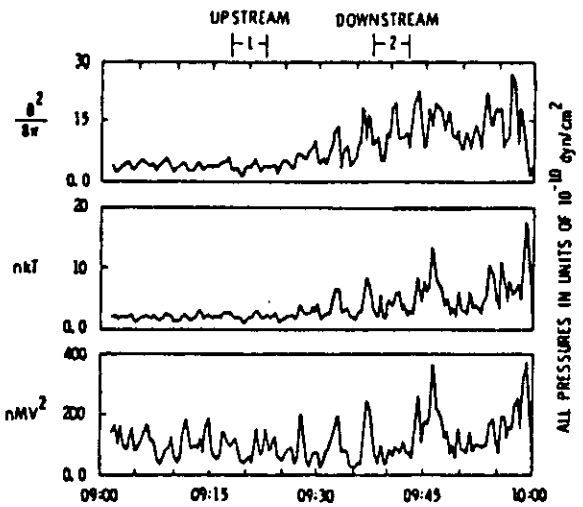
P.I.	INSTRUMENT	SAMPLING PERIOD (SEC)	SPATIAL RESOLUTION (km)
1. SMITH	MAGNETOMETER	1/3	7
2. SCARF	PLASMA WAVES		
	16 CHANNEL E	1	21
	8 CHANNEL B	16	330
3. BAME	PLASMA ELECTRONS	24	500
4. HYNDS	ENERGETIC PROTONS	32	660
5. STEINBERG	RADIO WAVES	56	1,200
6. HOVESTADT	ENERGETIC ION COMPOSITION	504	10,800
7. OGILVIE	PLASMA IONS	1,270	26,000





85-11

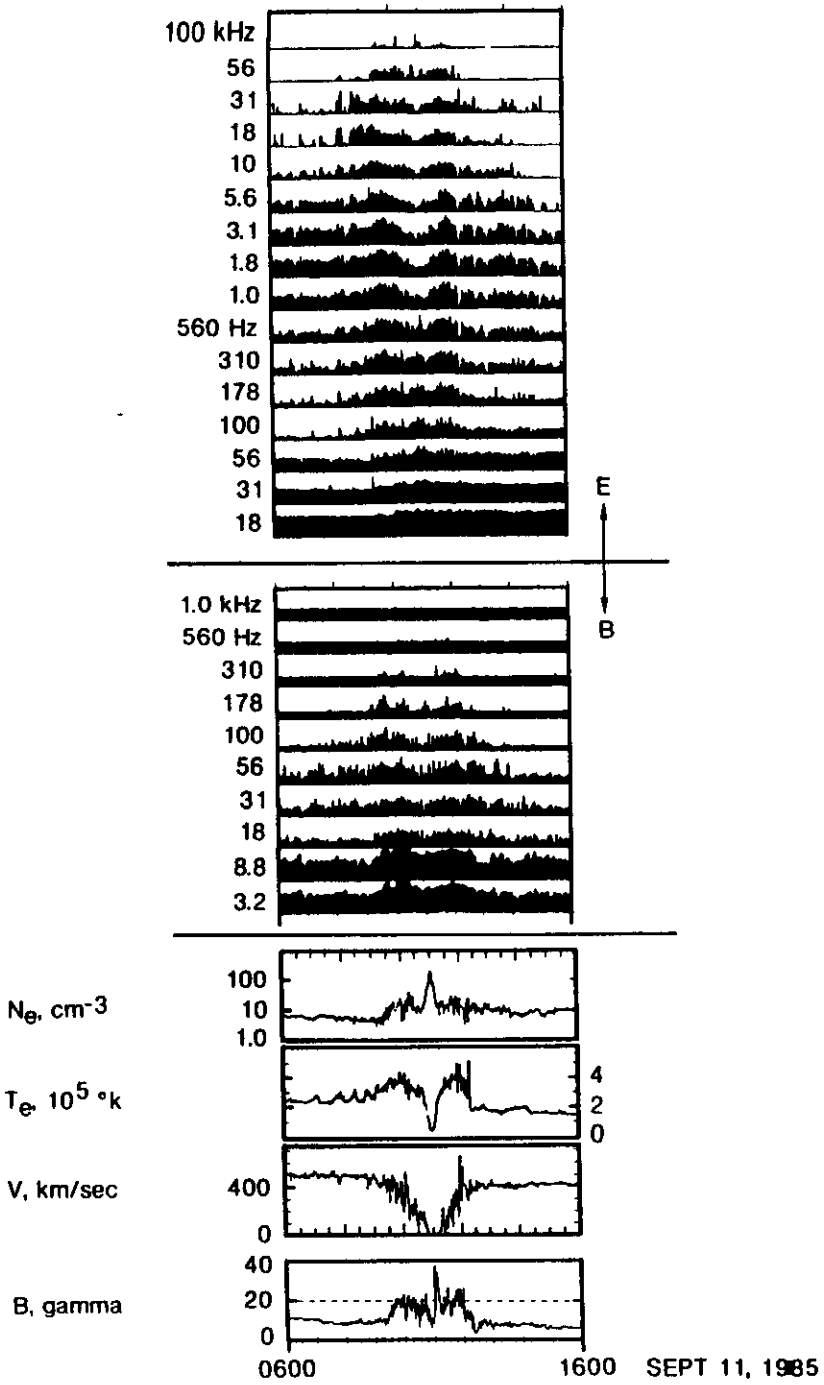
INBOUND: Comet Giacobini-Zinner

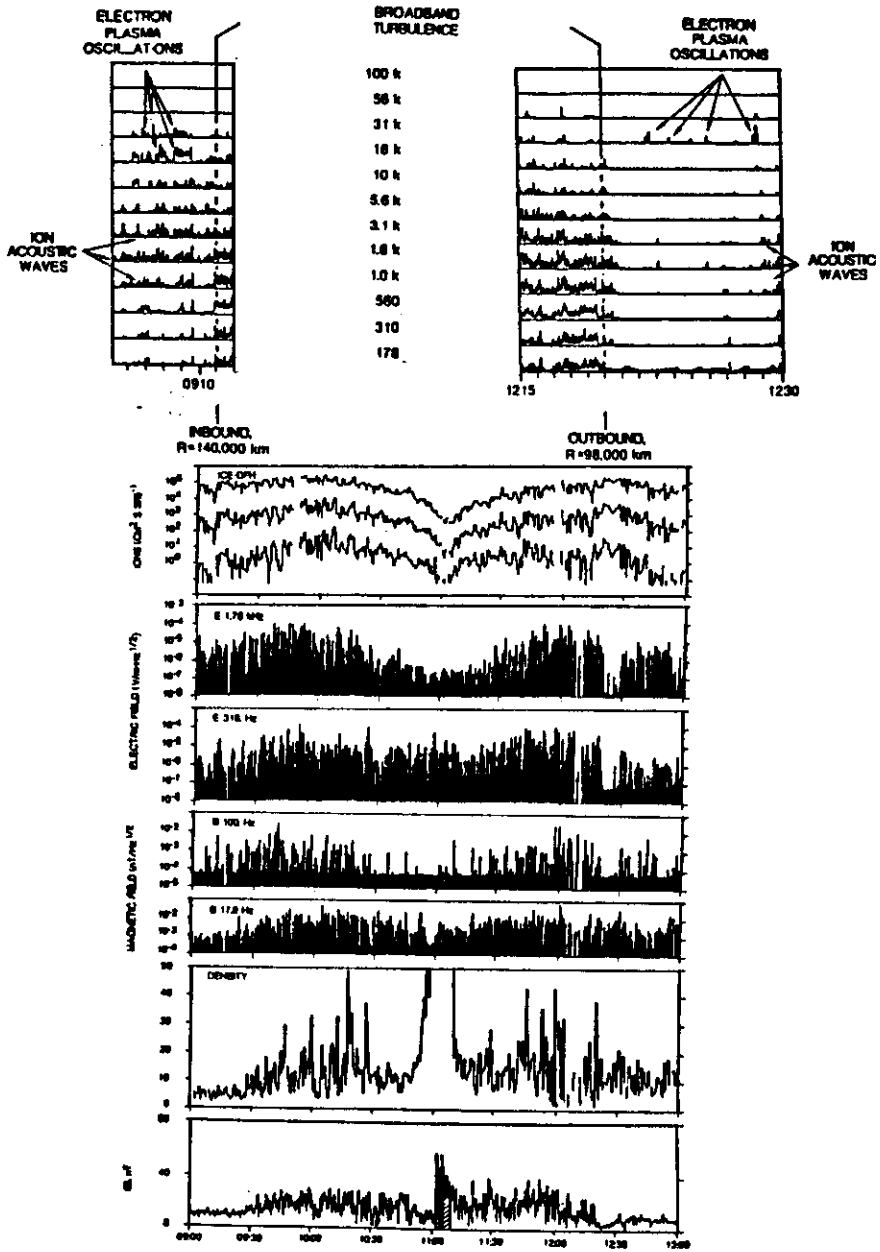


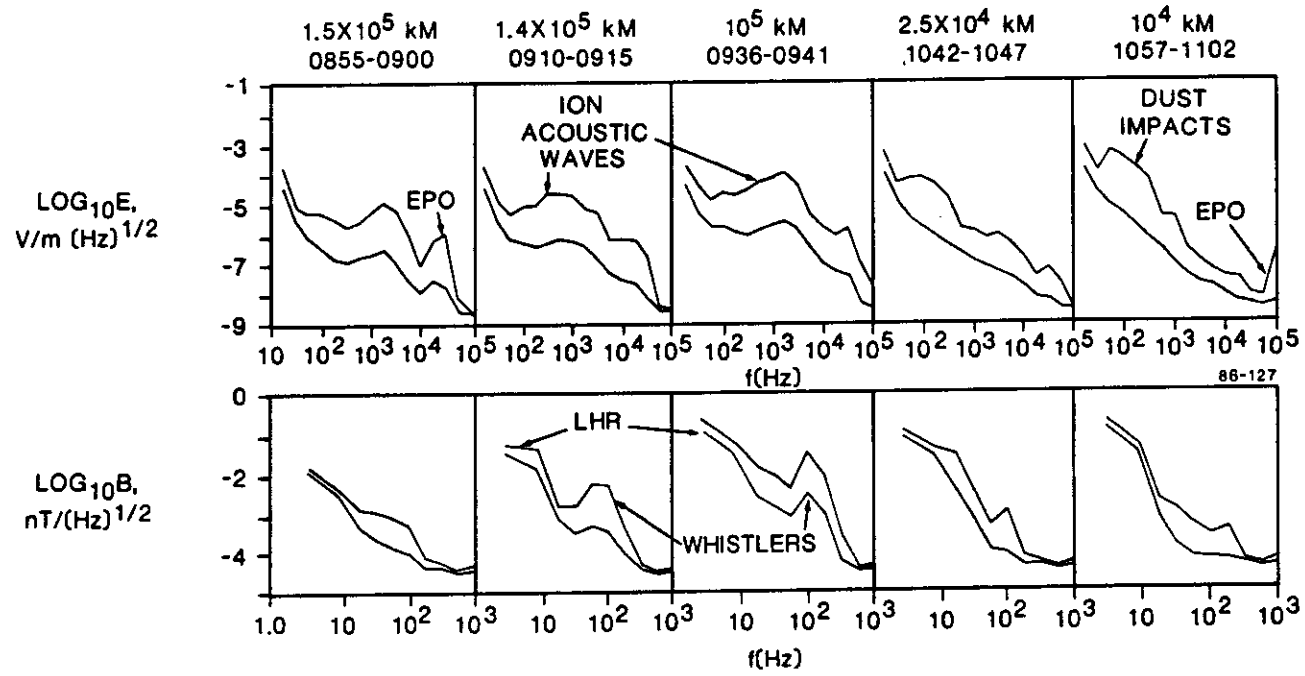
Three of the principal pressures (magnetic, solar wind electron and solar wind convective pressures) are shown. The horizontal bars above the data show the analysis intervals corresponding to the results in Table I.

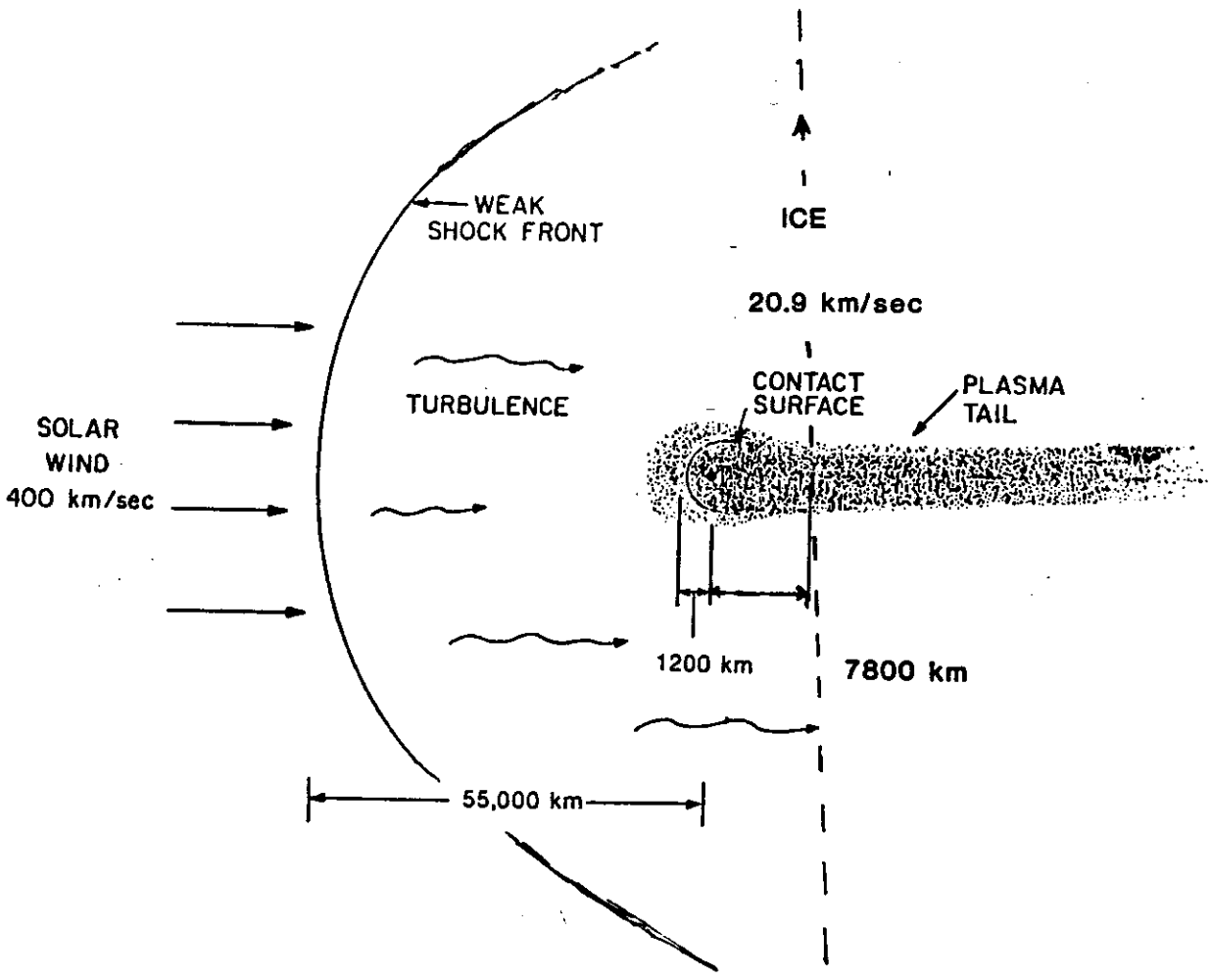
TABLE I.

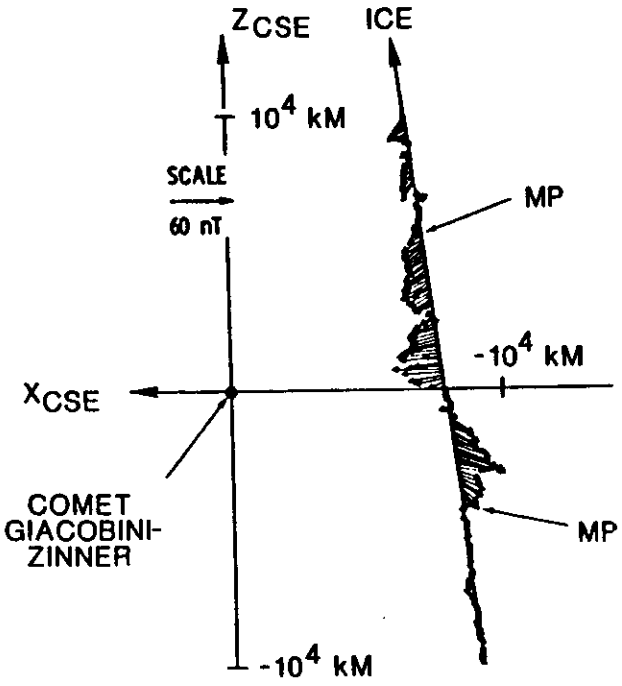
- $\hat{n}$: 0.1210, -0.7089, -0.6948
- θ_{Bn}: 80.1° PERPENDICULAR
- $V_s = |\Delta V \times B_2| / |\Delta B| = 189$ km/s
- $V_s = (N_2/N_2 - N_1)\Delta V \cdot \hat{n} = 189$ km/s
- $V_1 \cdot \hat{n} = -102$, $V_1 = 86$ km/s
- $C_A = 68$, $C_S = 106$ km/s
  $C_f = 125$ km/s
- $M \cong \frac{189}{125} = 1.5 > 1.0$
- A SHOCK


100 kHz
56
31
18
10
5.6
3.1
1.8
1.0
560 Hz
310
178
100
56
31
18
E
1.0 kHz
560 Hz
310
178
100
56
31
18
8.8
3.2
B
N_e, cm^{-3}
100
10
1.0
T_e, 10^5 °k
4
2
0
V, km/sec
400
0
B, gamma
40
20
0
0600
1600
SEPT 11, 1985


ELECTRON PLASMA OSCILLATIONS
BROADBAND TURBULENCE
ELECTRON PLASMA OSCILLATIONS
ION ACOUSTIC WAVES
ION ACOUSTIC WAVES
0910
1215
1230
INBOUND, R=140,000 km
OUTBOUND, R=98,000 km
DENSITY

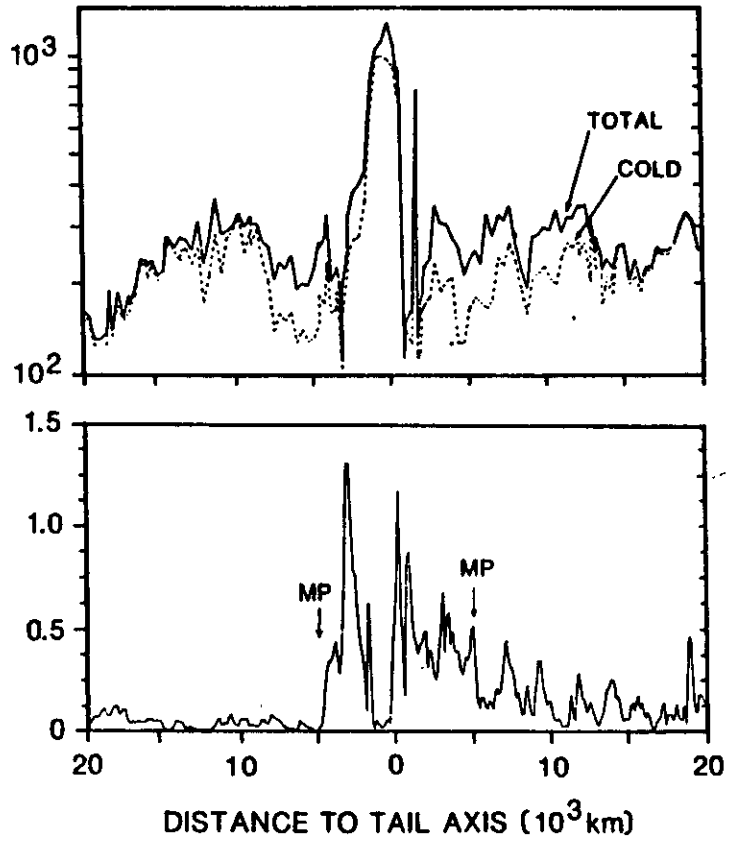

1.5X10^5 kM
0855-0900
1.4X10^5 kM
0910-0915
10^5 kM
0936-0941
2.5X10^4 kM
1042-1047
10^4 kM
1057-1102
LOG10E,
V/m (Hz)^1/2
EPO
ION
ACOUSTIC
WAVES
DUST
IMPACTS
EPO
f(Hz)
86-127
LOG10B,
nT/(Hz)^1/2
LHR
WHISTLERS
f(Hz)

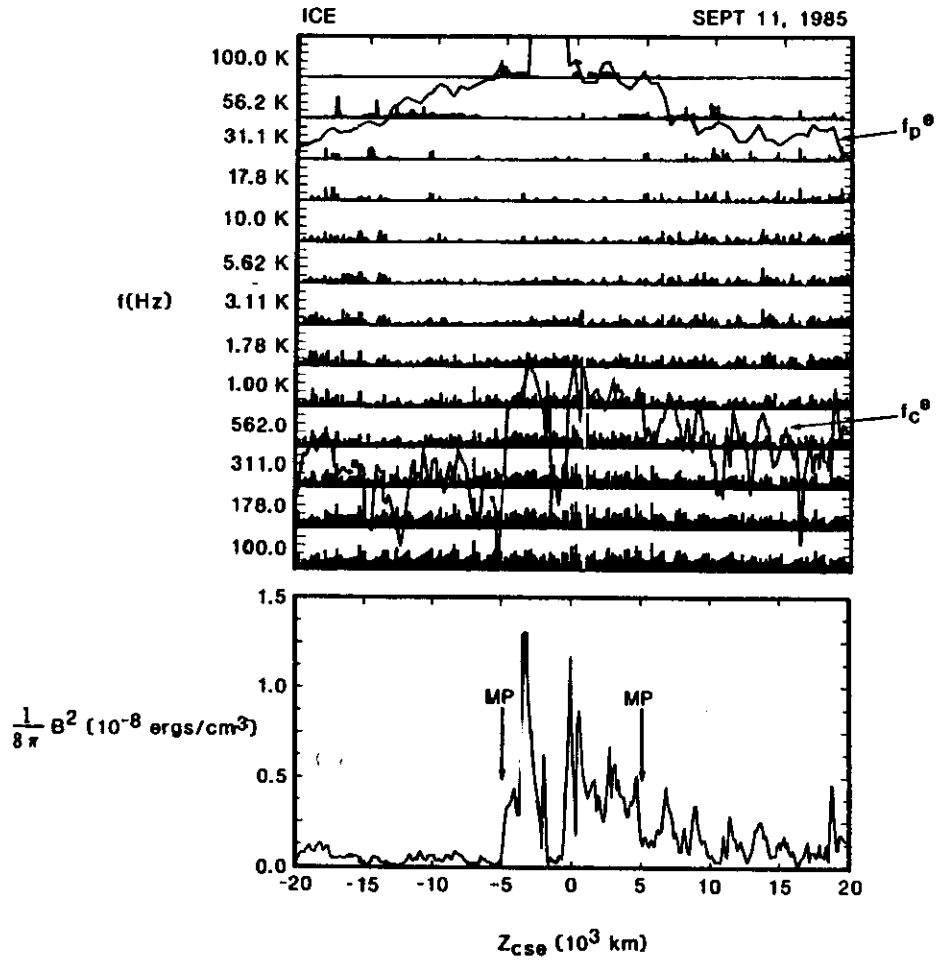

WEAK
SHOCK FRONT
ICE
20.9 km/sec
TURBULENCE
CONTACT
SURFACE
PLASMA
TAIL
SOLAR
WIND
400 km/sec
1200 km
7800 km
55,000 km



ELECTRON PRESSURE ($eV\ cm^{-3}$)

$\frac{B^2}{3\pi}$ (10^{-8} dynes/cm^2)




ICE
SEPT 11, 1985
100.0 K
56.2 K
31.1 K
17.8 K
10.0 K
5.62 K
3.11 K
1.78 K
1.00 K
562.0
311.0
178.0
100.0
f(Hz)
f_p^e
f_c^e
1.5
1.0
0.5
0.0
MP
MP
-20
-15
-10
-5
0
5
10
15
20
$\frac{1}{8\pi} B^2$ (10^{-8} ergs/cm^3)
Z_{cse} (10^3 km)