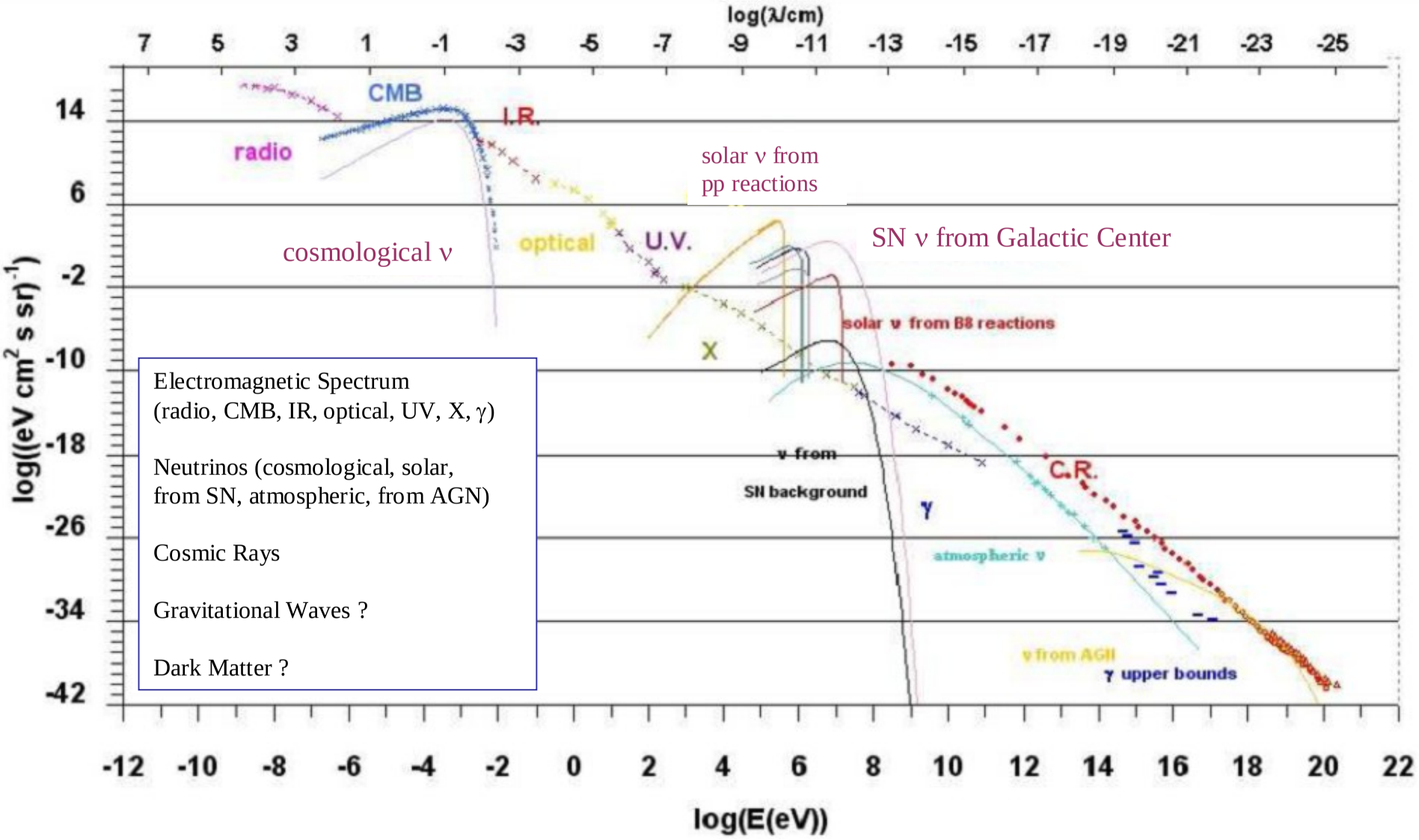

log(λ/cm)
7 5 3 1 -1 -3 -5 -7 -9 -11 -13 -15 -17 -19 -21 -23 -25
CMB
I.R.
radio
solar ν from
pp reactions
cosmological ν
optical
U.V.
SN ν from Galactic Center
X
solar ν from B8 reactions
ν from
SN background
γ
C.R.
atmospheric ν
ν from AGN
γ upper bounds
Electromagnetic Spectrum
(radio, CMB, IR, optical, UV, X, γ)
Neutrinos (cosmological, solar,
from SN, atmospheric, from AGN)
Cosmic Rays
Gravitational Waves ?
Dark Matter ?
log((eV cm^2 s sr)$^{-1}$)
14 6 -2 -10 -18 -26 -34 -42
-12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22
log(E(eV))

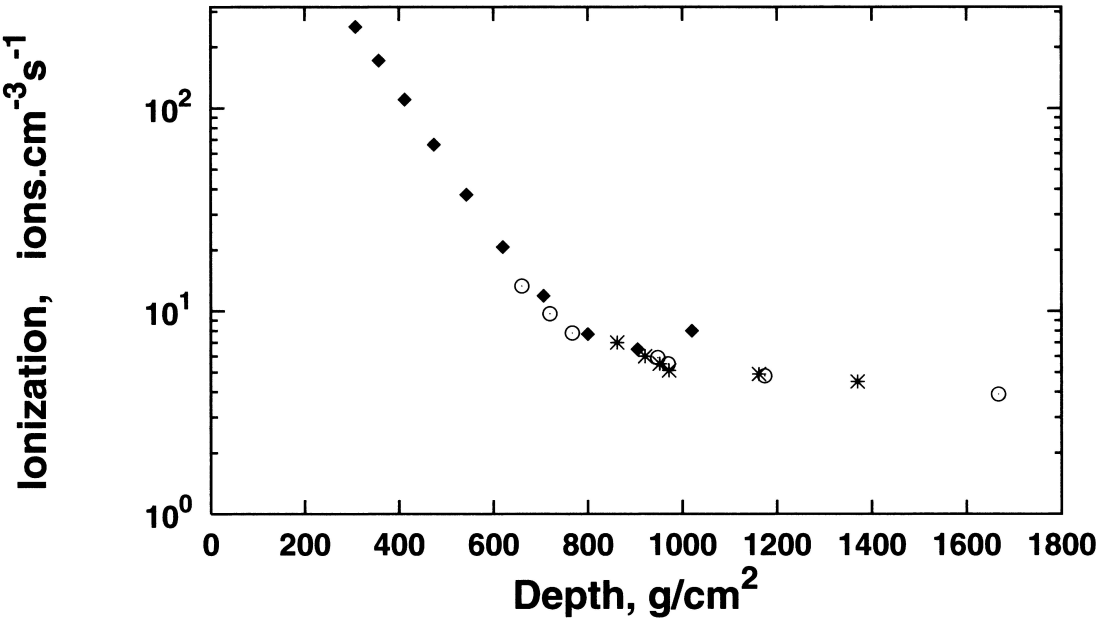
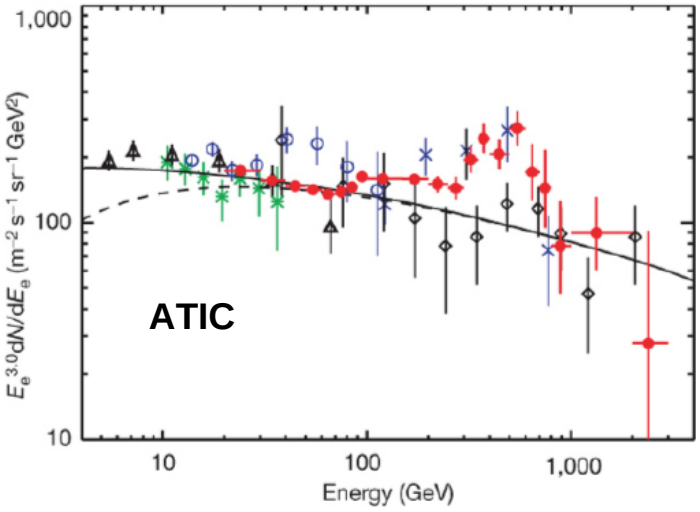
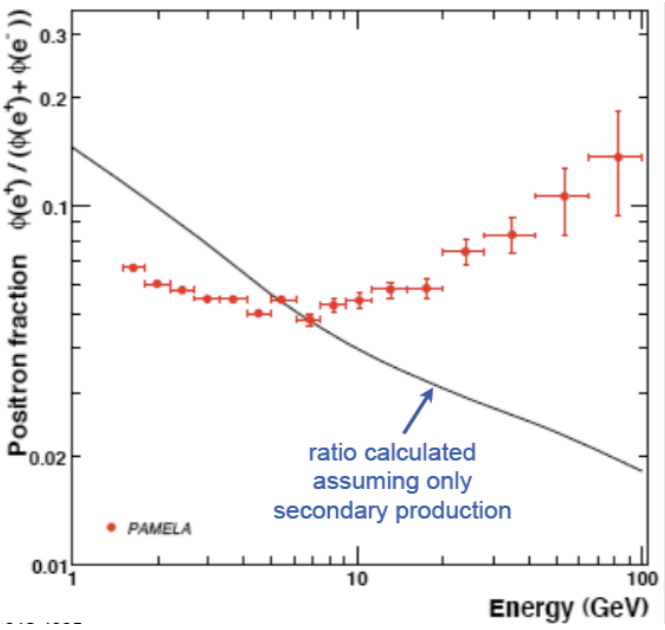
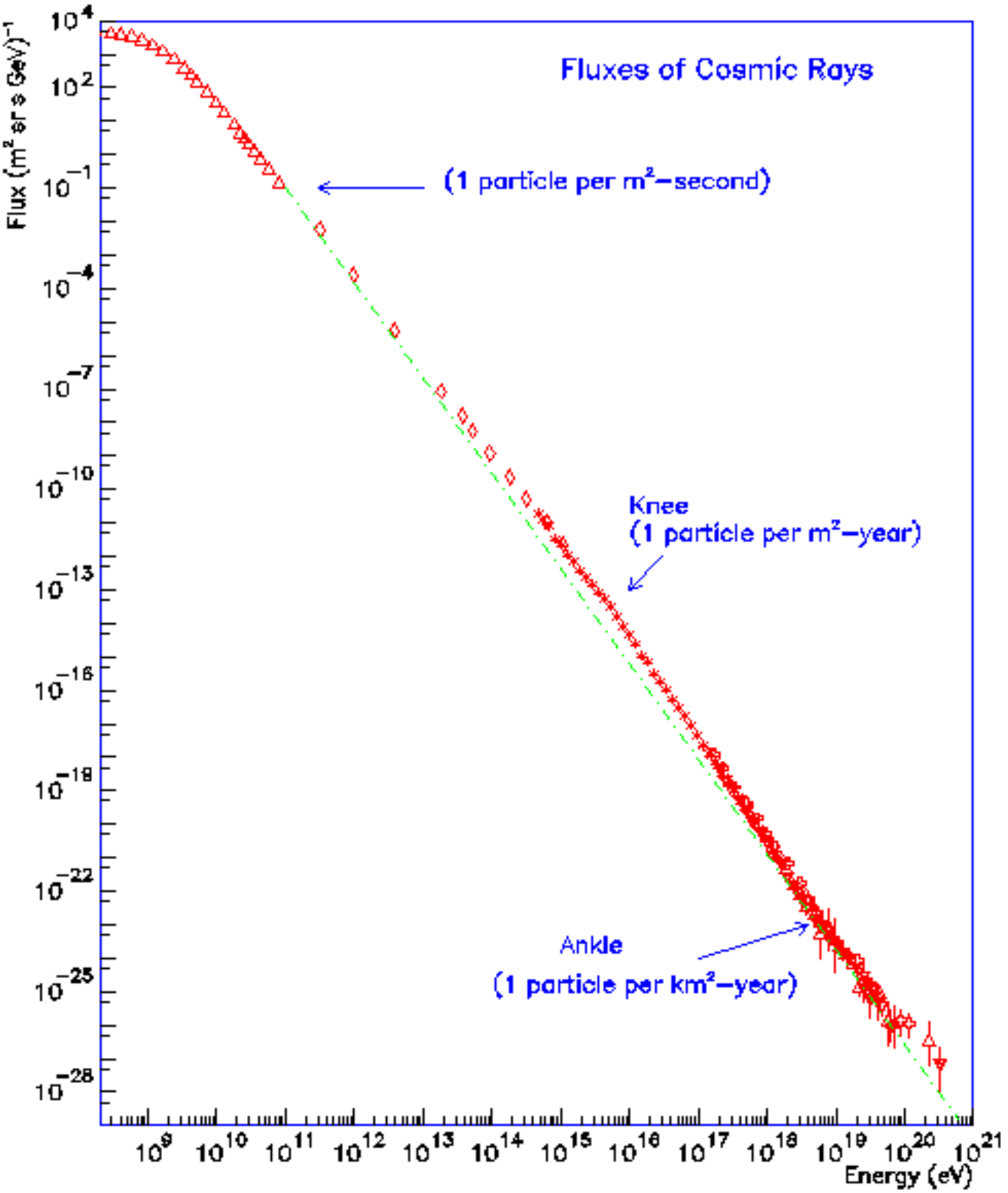
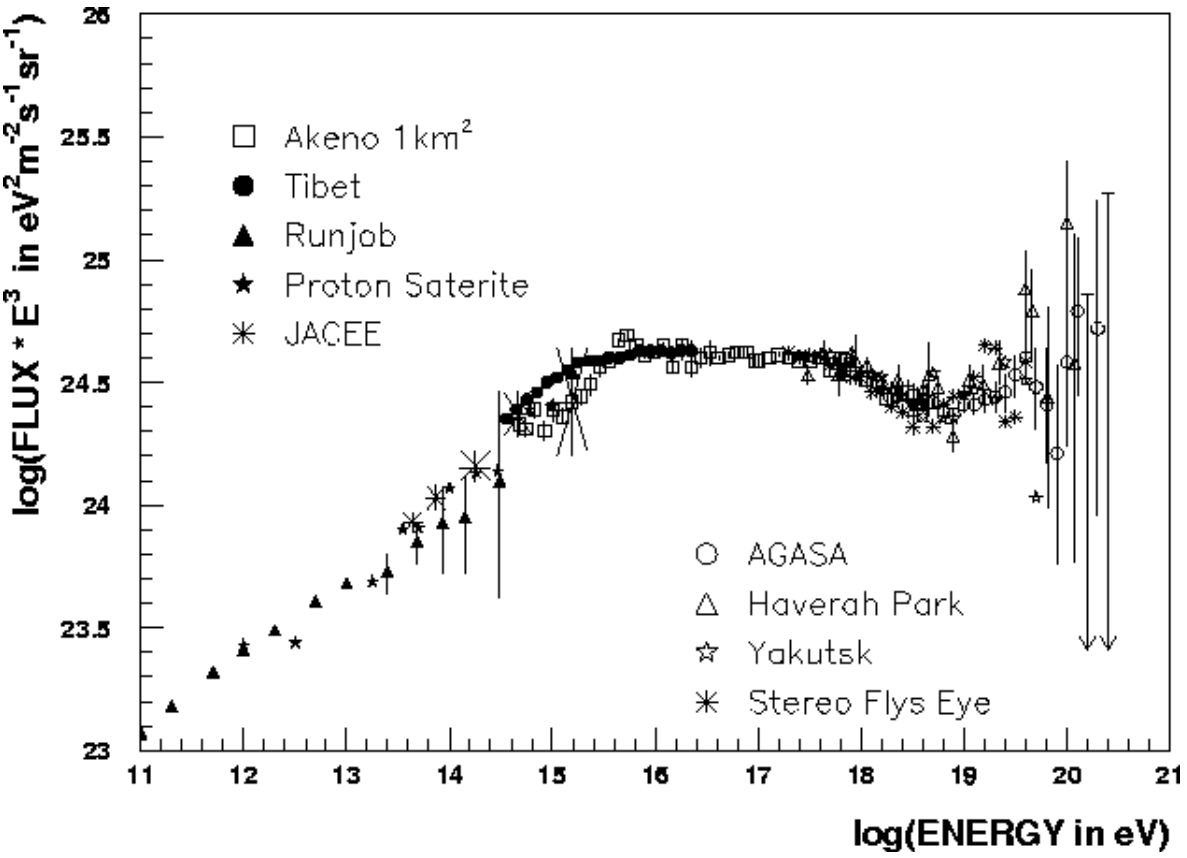


Fig. 1.1. The ionization as a function of the depth in the atmosphere. The diamonds are from the flight of Kohlhörster and the circles and asterisks are from the underwater measurements of Millikan.






Fluxes of Cosmic Rays
(1 particle per m²–second)
Knee
(1 particle per m²–year)
Ankle
(1 particle per km²–year)
Flux (m² sr s GeV)⁻¹
Energy (eV)
10⁴
10²
10⁻¹
10⁻⁴
10⁻⁷
10⁻¹⁰
10⁻¹³
10⁻¹⁶
10⁻¹⁹
10⁻²²
10⁻²⁵
10⁻²⁸
10⁹ 10¹⁰ 10¹¹ 10¹² 10¹³ 10¹⁴ 10¹⁵ 10¹⁶ 10¹⁷ 10¹⁸ 10¹⁹ 10²⁰ 10²¹



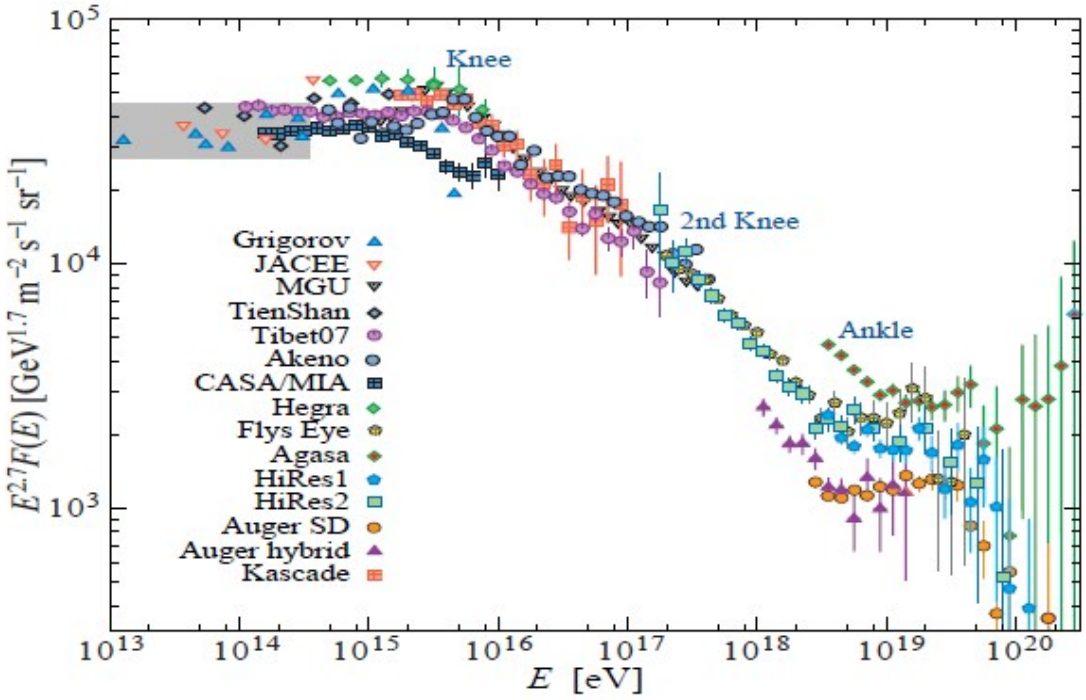
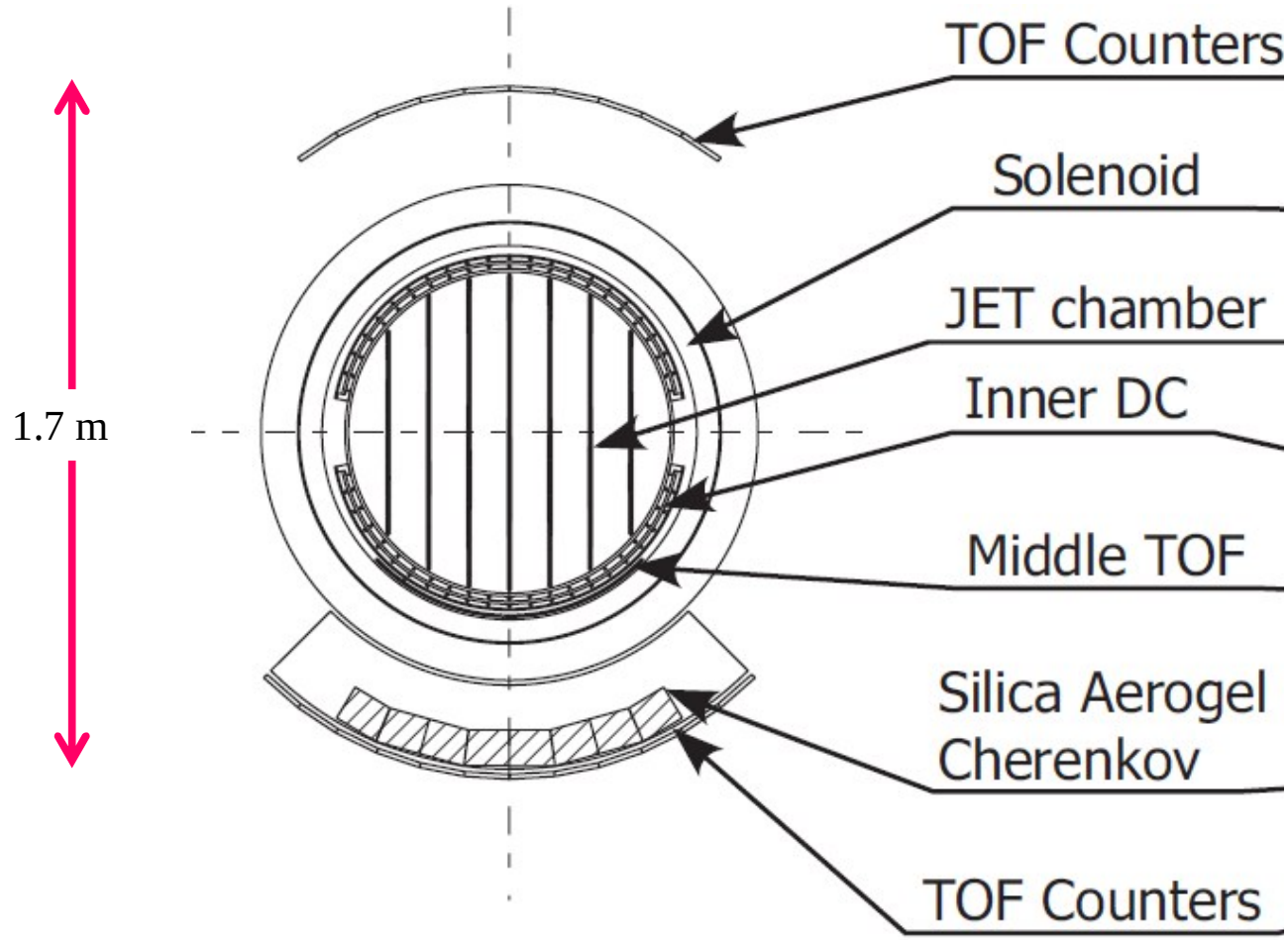


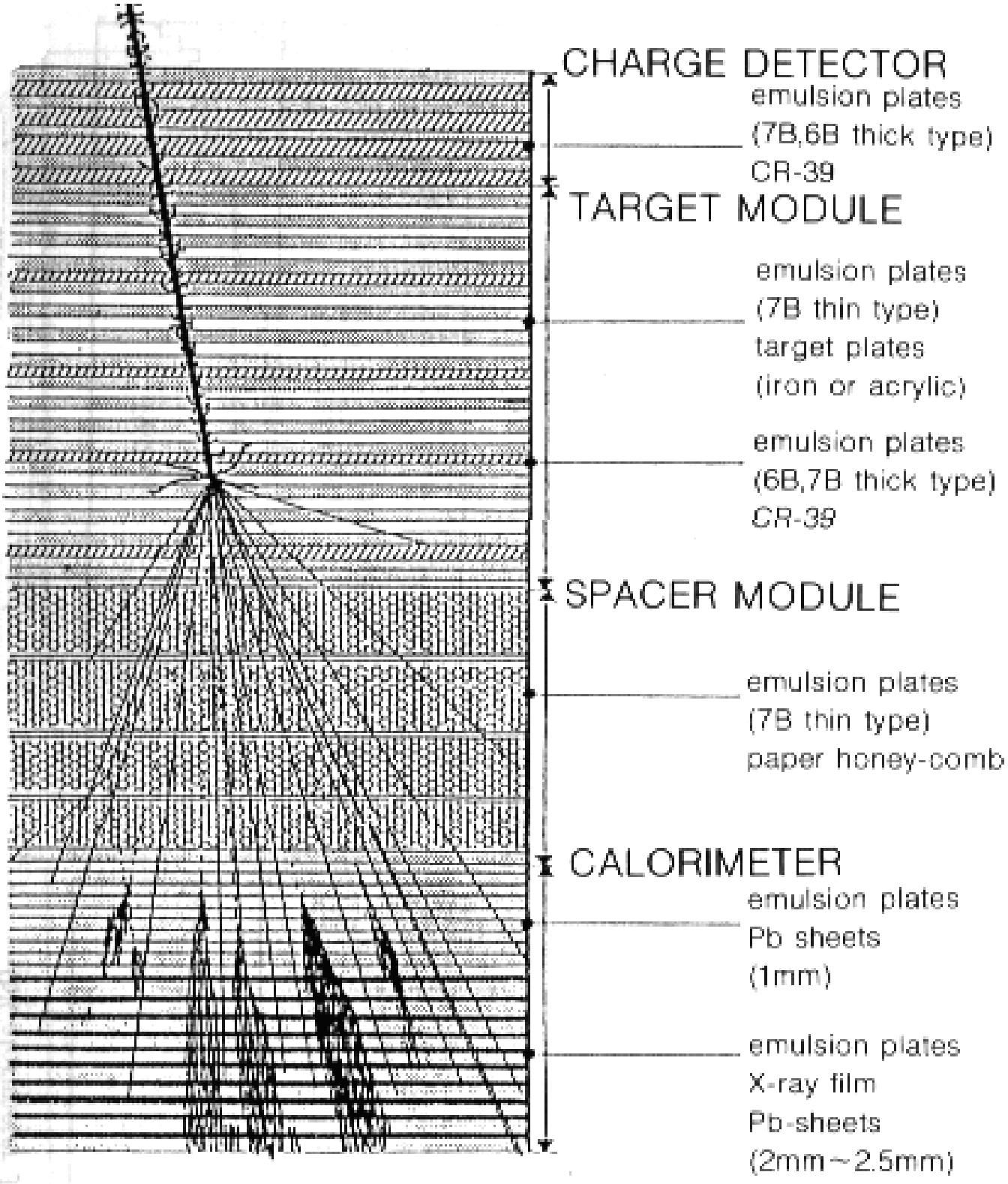
Figure 2.2: The high energy, all-particle cosmic ray spectrum multiplied by $E^{2.7}$ for indirect experiments, demonstrating the rather substantial spread in the data. The grey band shows the reach of direct detection experiments as of 2008. [4]

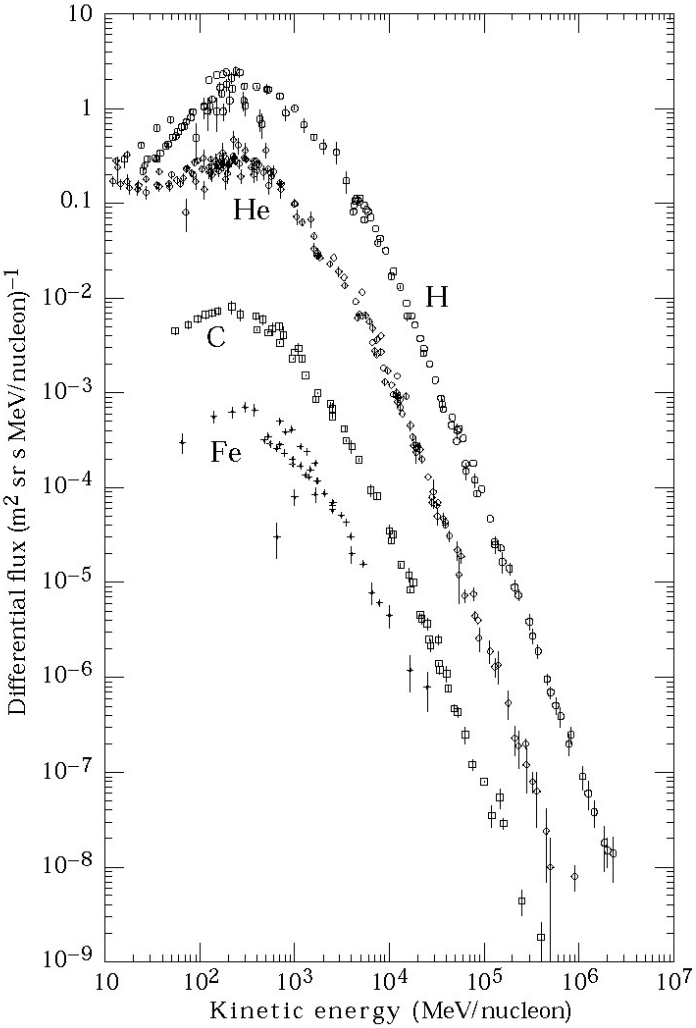
BESS – Balloon-born Experiment with Superconducting Spectrometer



- ToF Counters — scintillatori, misurano tempi e perdita di energia
- Solenoid — generatore del campo magnetico (1 Tesla)
- JET chamber — tracciatore centrale con camera a drift, in campo magnetico
- Inner DC — camere a drift interne
- Silica Aerogel Cherenkov — rivelatore Cherenkov

JACEE


CHARGE DETECTOR
emulsion plates
(7B,6B thick type)
CR-39
TARGET MODULE
emulsion plates
(7B thin type)
target plates
(iron or acrylic)
emulsion plates
(6B,7B thick type)
CR-39
SPACER MODULE
emulsion plates
(7B thin type)
paper honey-comb
CALORIMETER
emulsion plates
Pb sheets
(1mm)
emulsion plates
X-ray film
Pb-sheets
(2mm~2.5mm)



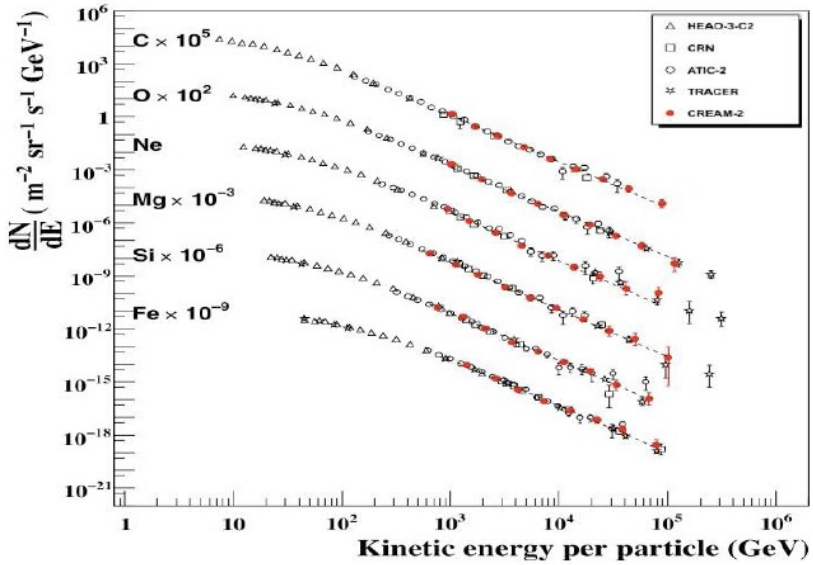


Figure 5.3: Red circles denote the spectra measured by CREAM II for the primary cosmic ray nuclei: Carbon, Oxygen, Neon, Magnesium, Silicon, and Iron. The data are consistent with both the space-based HEAO and CRN measurements and TRACER and ATIC 2, two other balloon-born instruments utilizing different detection techniques. The dashed lines represent power law fits to the CREAM data.

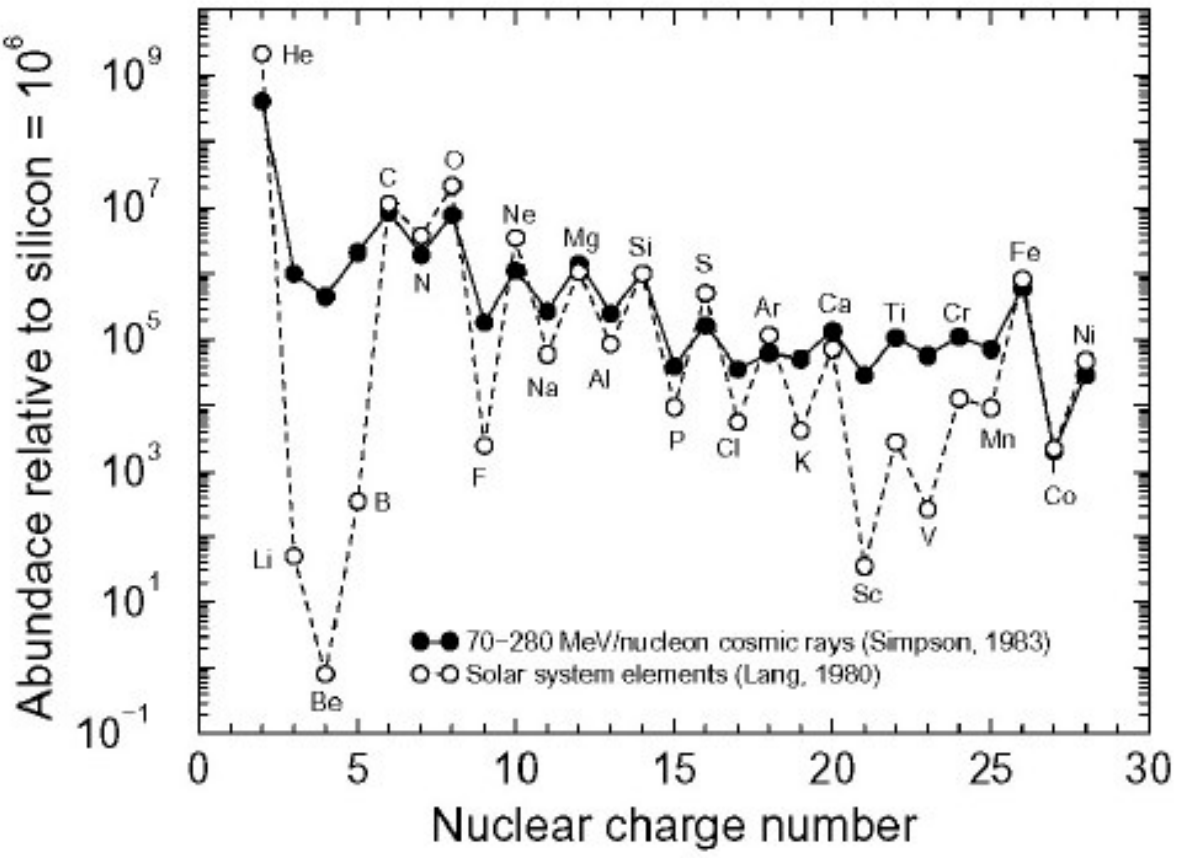


Fig. 2.— The relative elemental abundances of 70-280 Mev/nucleon cosmic rays (closed circles, taken from Tab. 2 by Simpson, 1983) compared to the solar system abundances (open circles, taken from Tab. 38 by Lang, 1980) normalized to Si = 10^6.

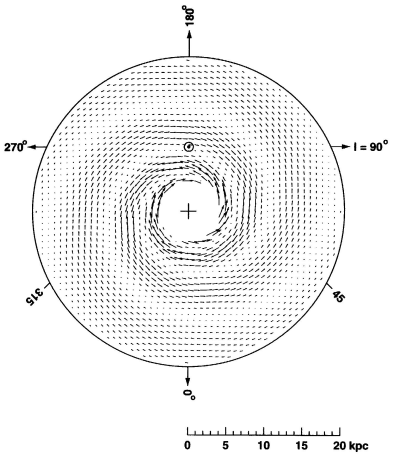
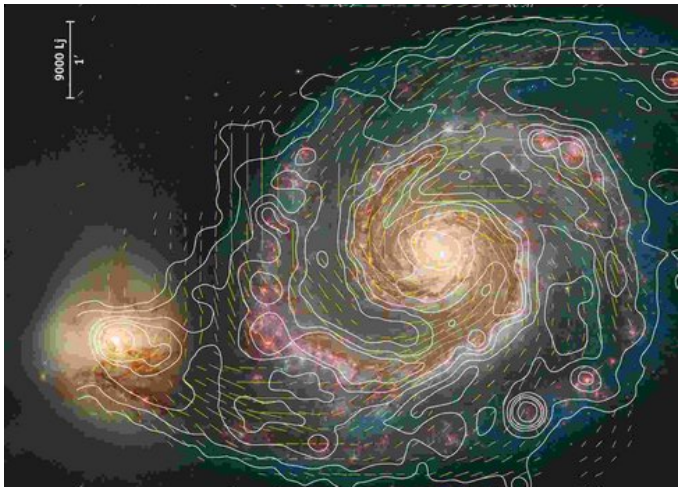
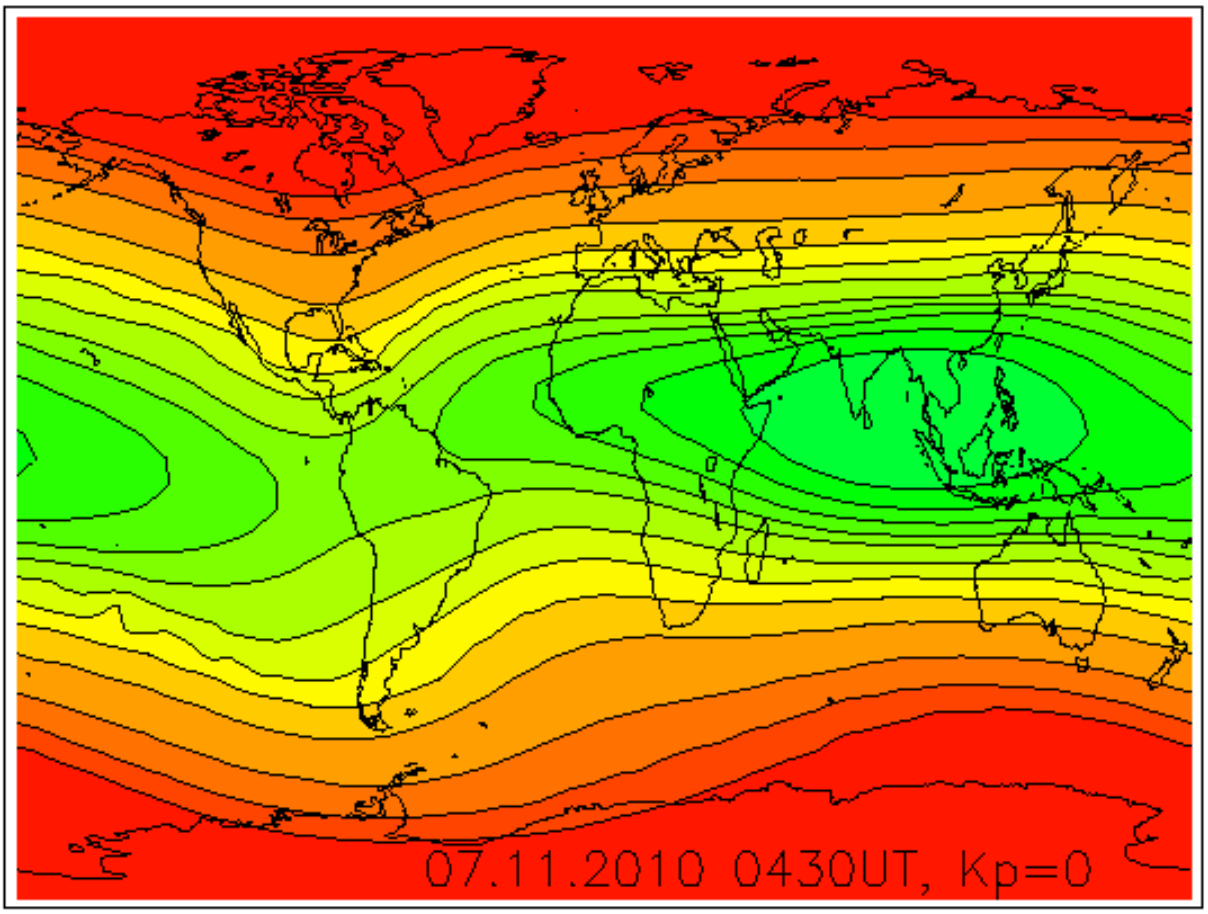


Fig. 4.4. Magnetic field strength (length of arrows) and direction in the galactic plane for the BSS model [76]. The field reversals can be best seen close to the galactic center where the field values are higher. The field is not plotted within 4 kpc of the galactic center because of the very high uncertainty in this region. The positions of the galactic center and the solar system are indicated.



Campo magnetico di una galassia simile alla via Lattea


07.11.2010 0430UT, Kp=0

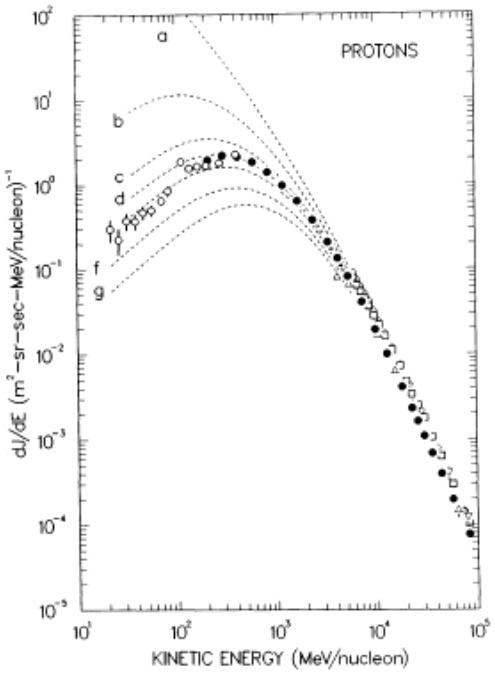


FIG. 9a

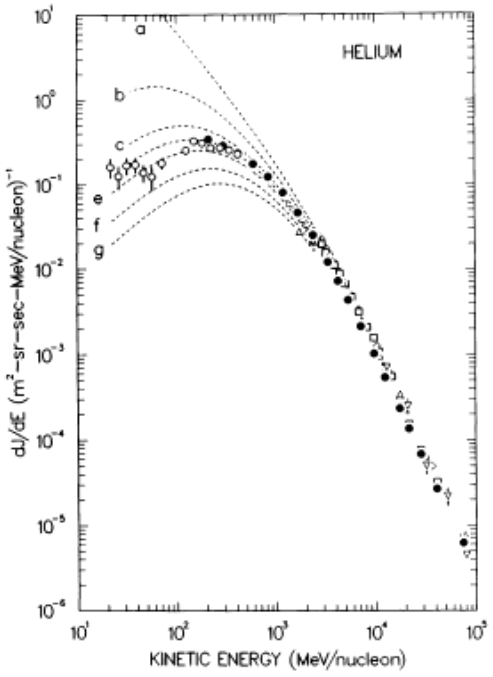
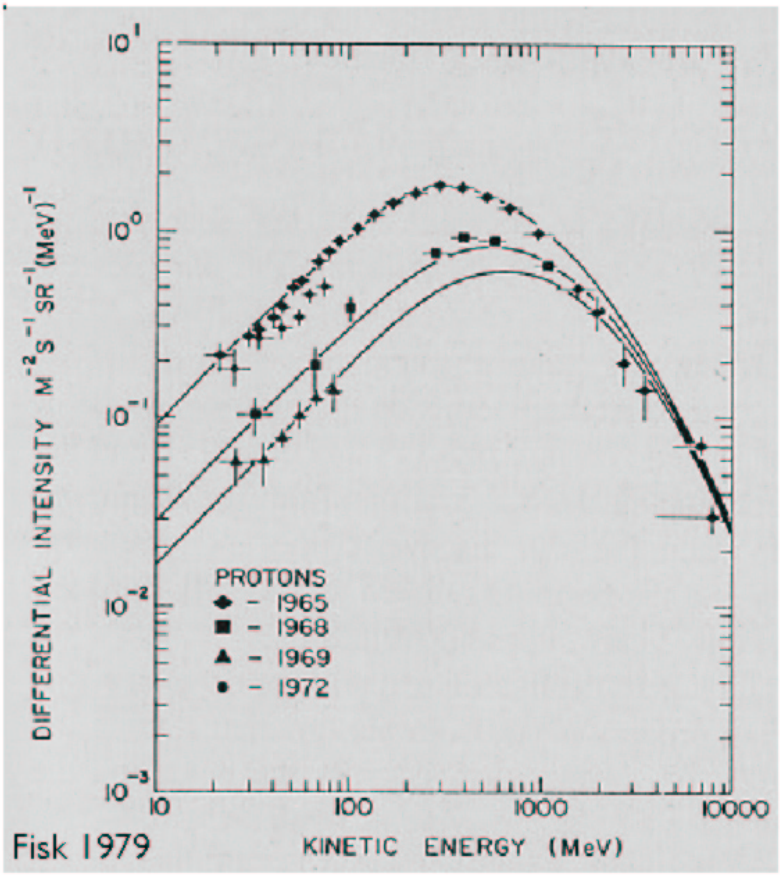
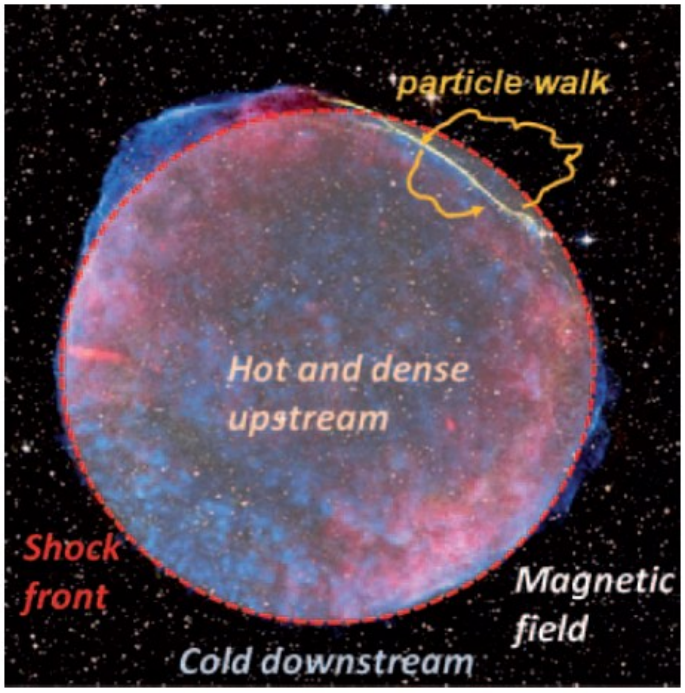
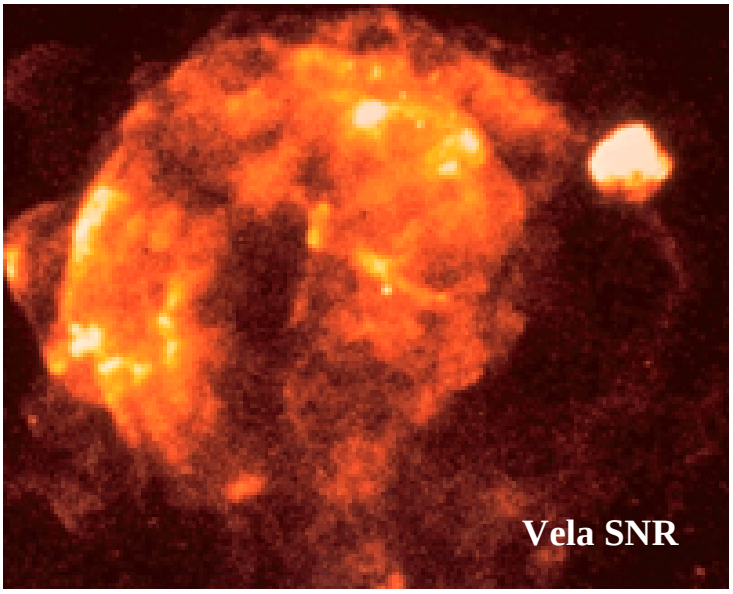


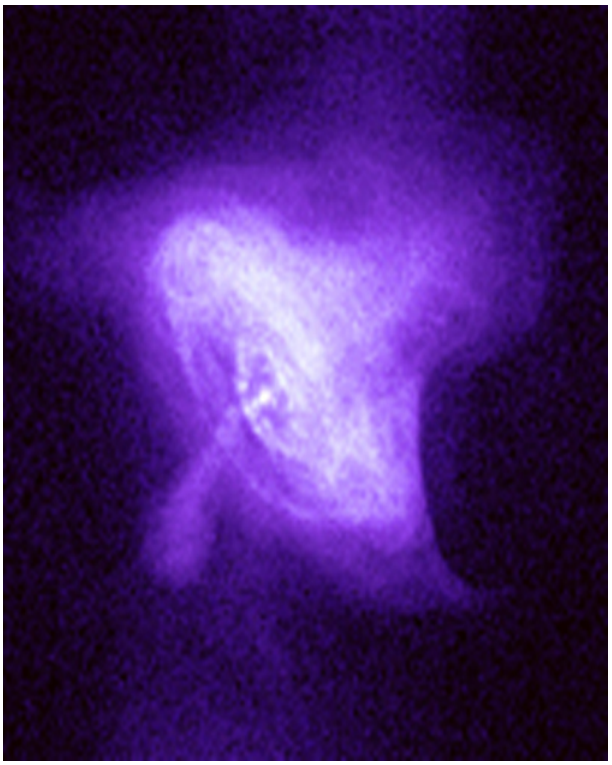
FIG. 9b

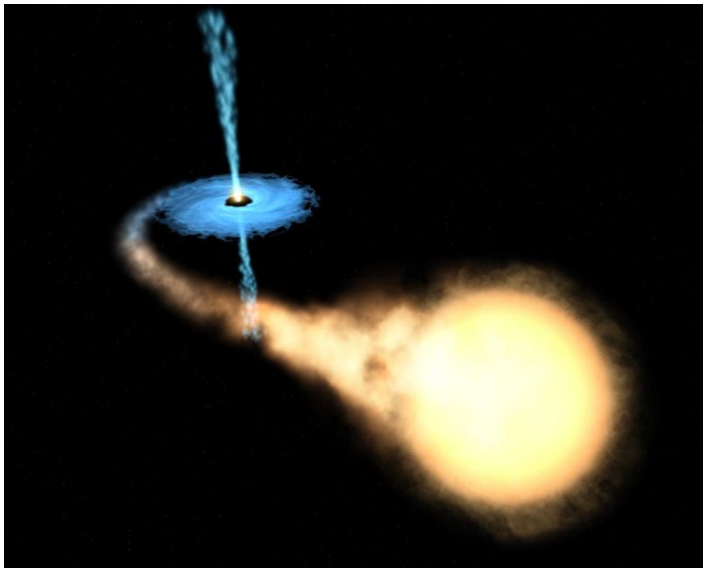
FIG. 9.—Differential energy spectra for cosmic-ray protons (*a*) and helium nuclei (*b*) measured in 1987 (*filled circles* for LEAP, *open circles* for *IMP 8*) along with the previous balloon measurements: *open diamonds* (1976 data), *open squares*, (1979 data), Webber et al. (1987); *inverted triangles*, Ryan et al. (1972); *upright triangles*, Smith et al. (1973). The dashed curves represent the local interstellar and modulated spectra with different amounts of modulation indicated by the modulation parameter ϕ: a, local interstellar spectra (no modulation); b, $\phi = 200$ MV; c, $\phi = 400$ MV; d, $\phi = 500$ MV; e, $\phi = 600$ MV; f, $\phi = 800$ MV; g, $\phi = 1000$ MV.

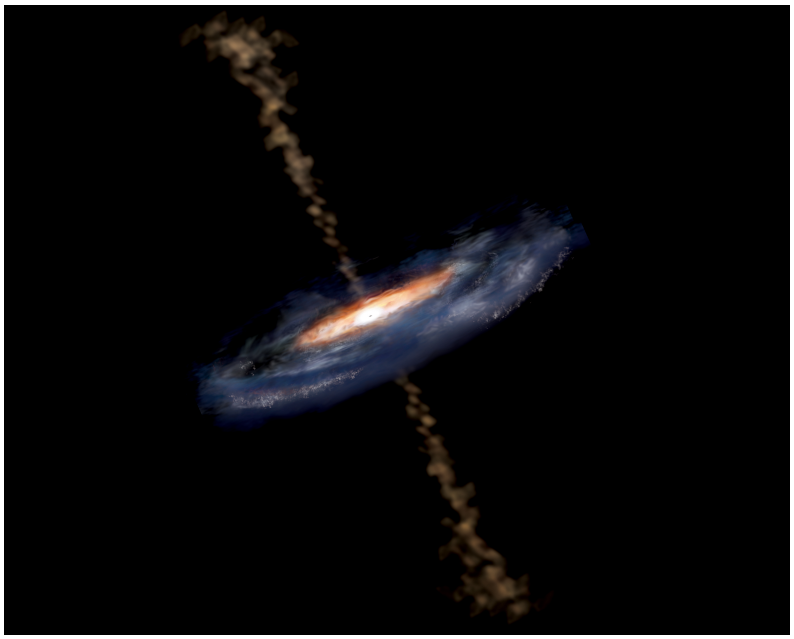


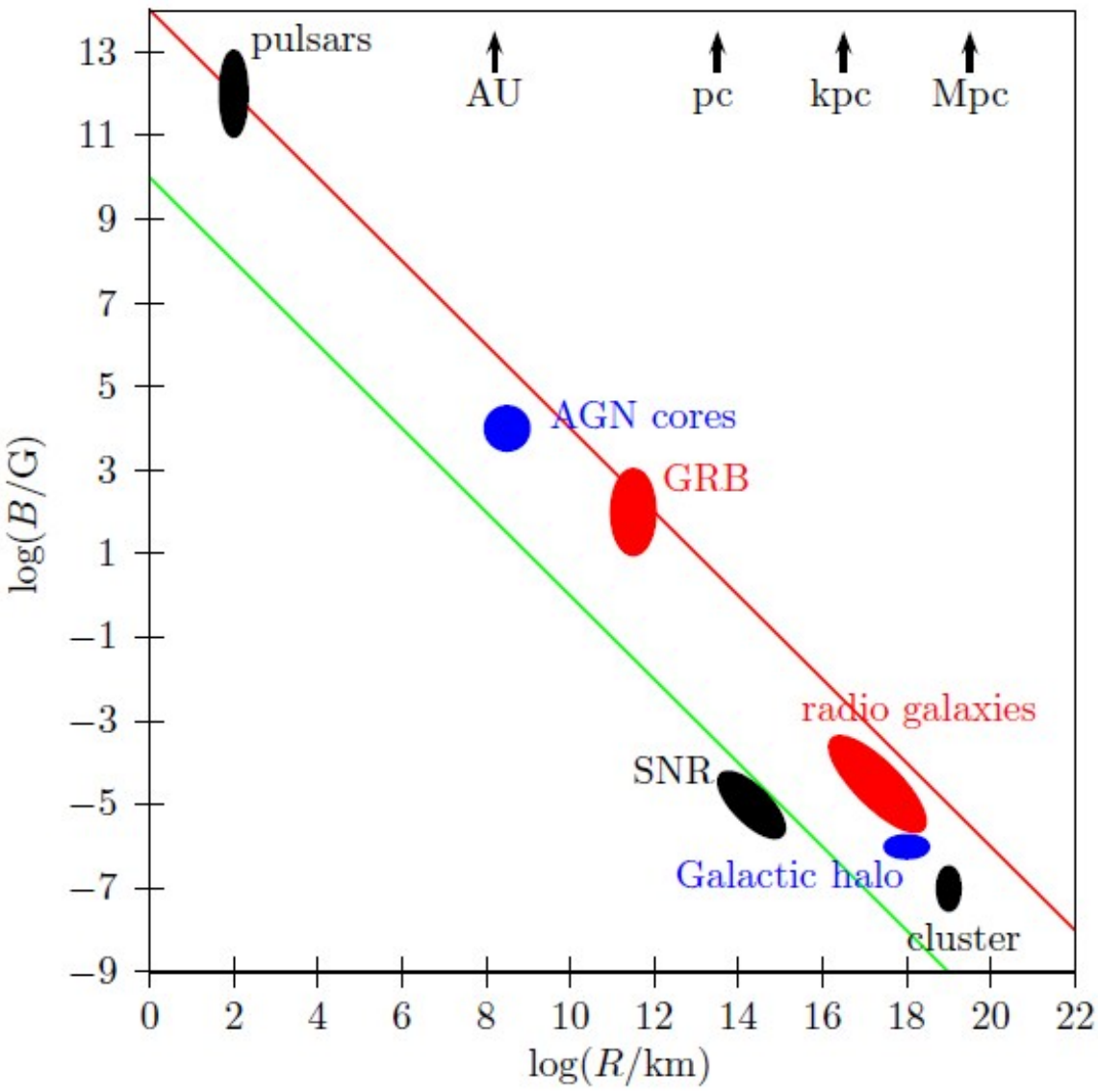

particle walk
Hot and dense upstream
Shock front
Magnetic field
Cold downstream

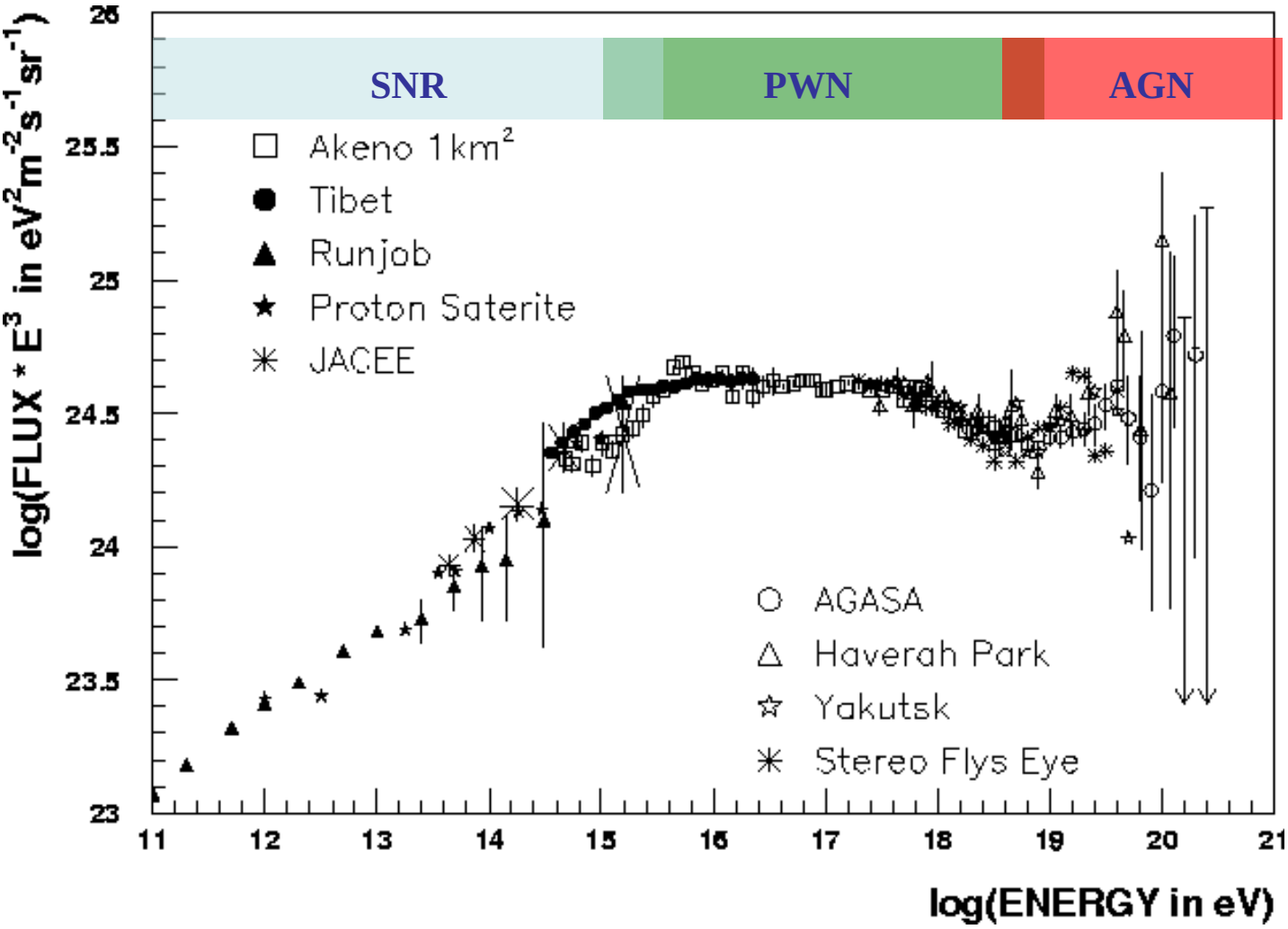

Vela SNR

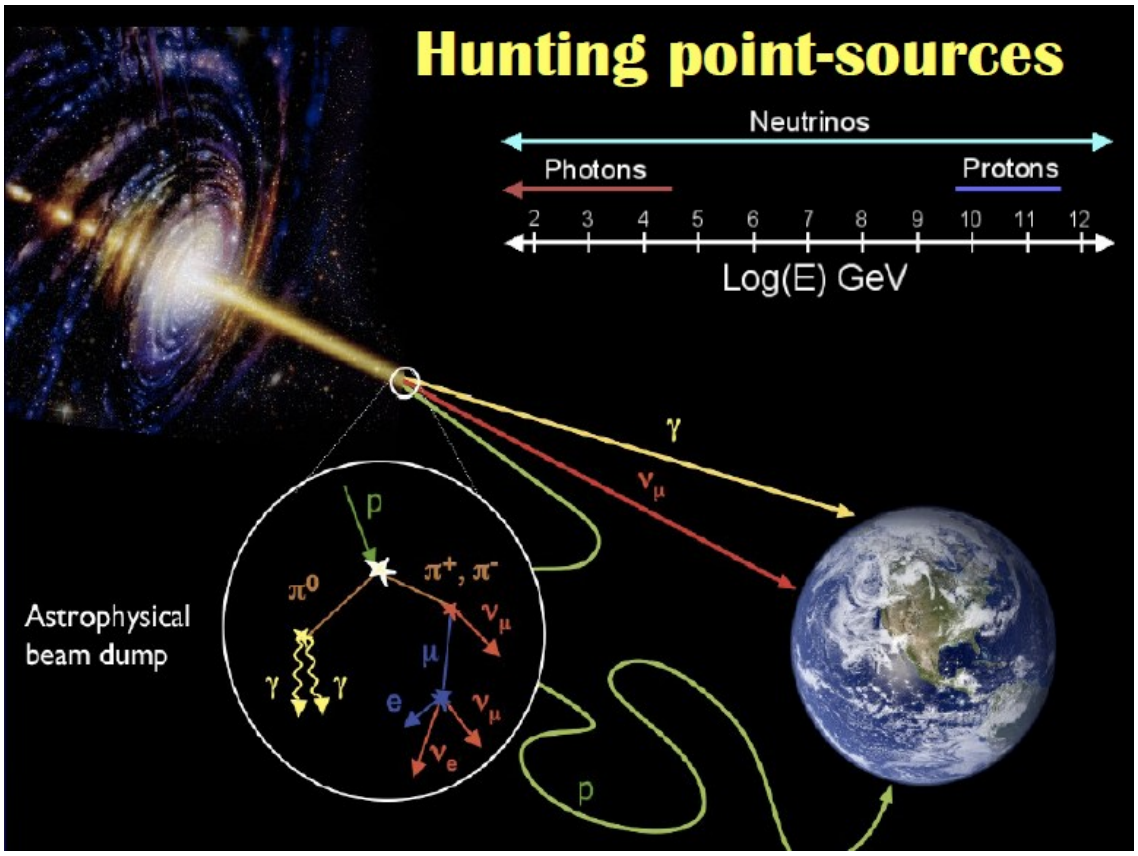


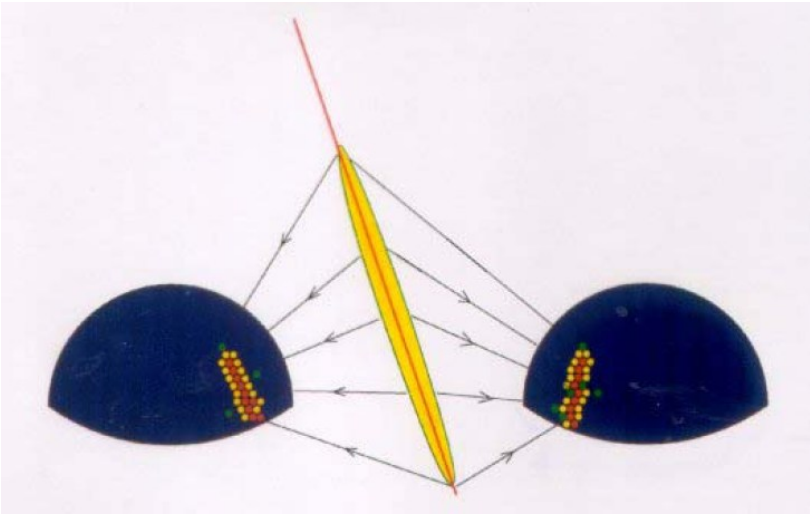





pulsars
AU
pc
kpc
Mpc
AGN cores
GRB
radio galaxies
SNR
Galactic halo
cluster
log(B/G)
log(R/km)
13
11
9
7
5
3
1
−1
−3
−5
−7
−9
0
2
4
6
8
10
12
14
16
18
20
22


SNR
PWN
AGN
Akeno 1km²
Tibet
Runjob
Proton Saterite
JACEE
AGASA
Haverah Park
Yakutsk
Stereo Flys Eye
log(FLUX * E³ in eV²m⁻²s⁻¹sr⁻¹)
log(ENERGY in eV)


Hunting point-sources
Neutrinos
Photons
Protons
Log(E) GeV
Astrophysical beam dump
p
π⁰
π⁺, π⁻
γ
e
p



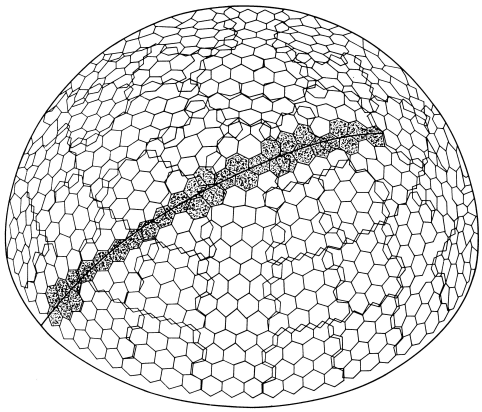


FIGURE 6.3 "Fly's Eye" phototube apertures. Shaded region represents light from EAS striking the detector. The solid line indicates the EAS trajectory across the sky.

FLY's EYE TECHNIQUE

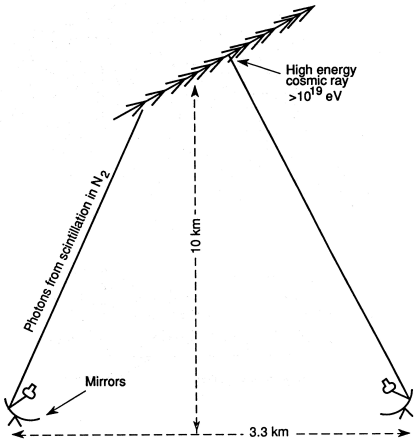


Figure 17: Fly's Eye technique [14].

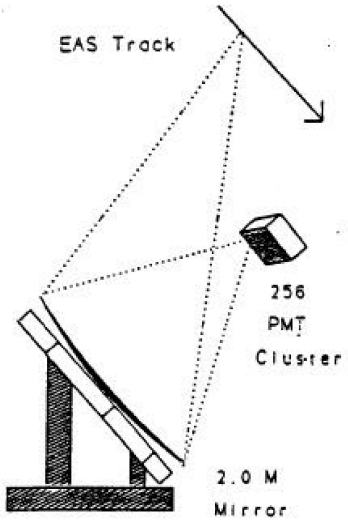


Figure 1: Single HiRes detection unit. The 2.0 m. mirror focuses nitrogen fluorescence from the EAS track onto the PMT cluster.

OG 10.4.9

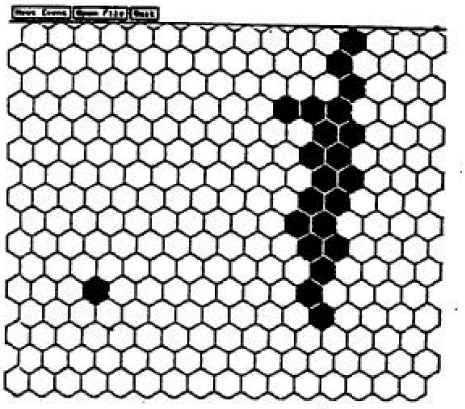
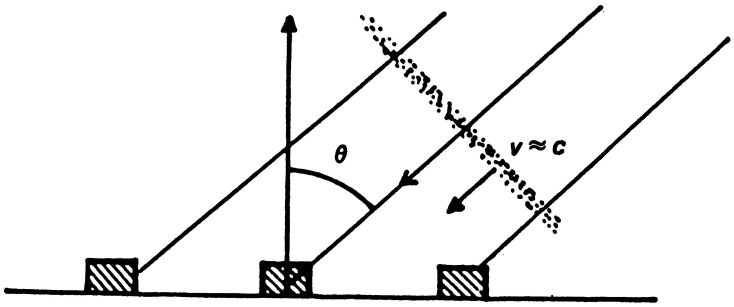
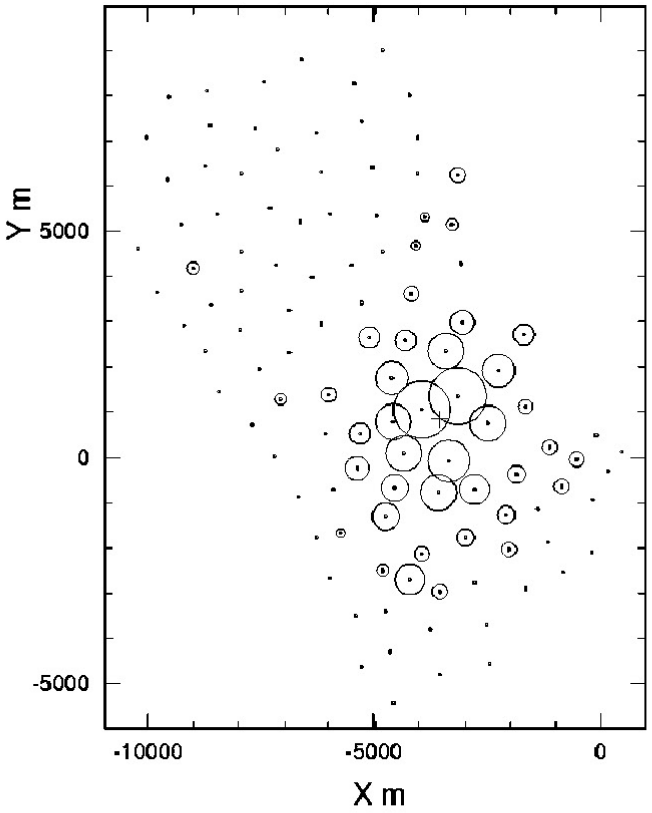
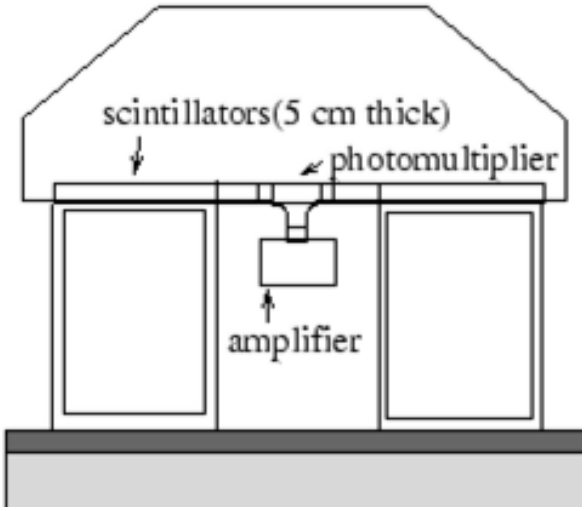


Figure 2: The first cosmic ray track observed by the prototype HiRes de-detector (January 20, 1991).

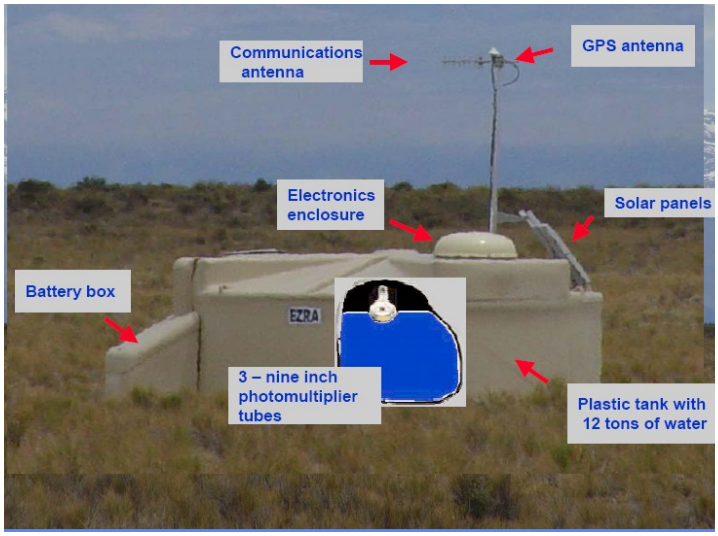
AGASA

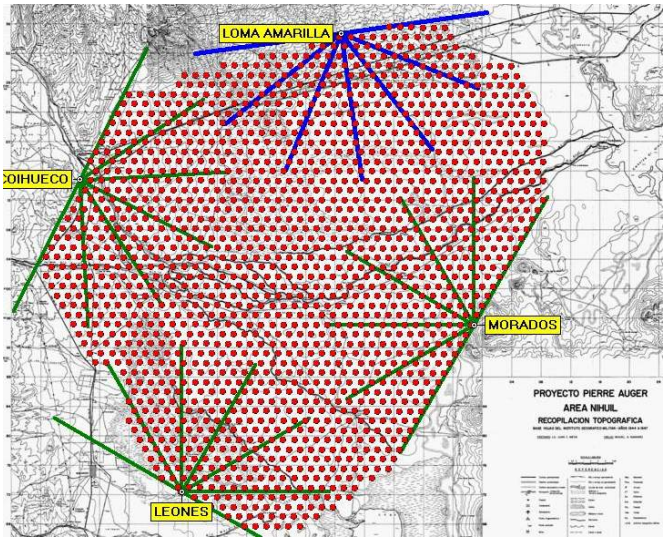

θ
v ≈ c

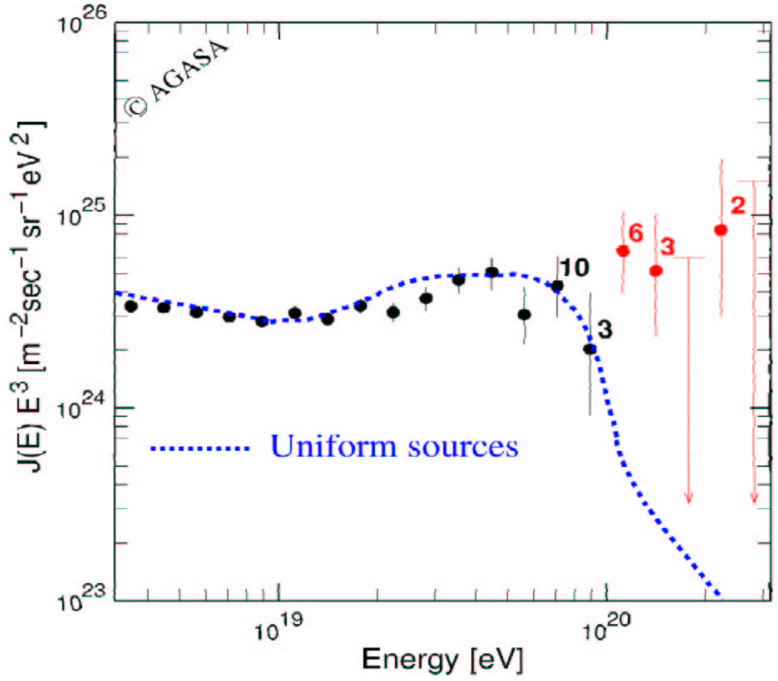

Y m
5000
0
-5000
-10000
-5000
0
X m

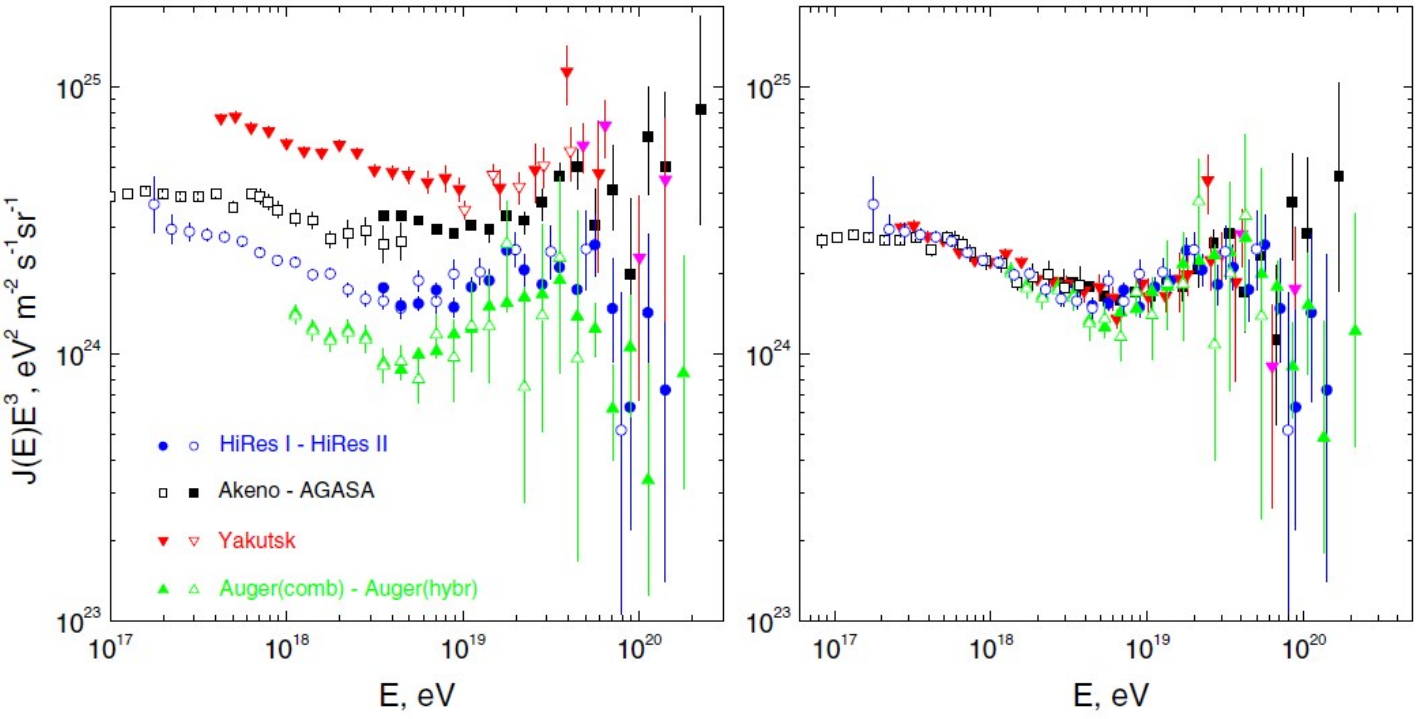

scintillators(5 cm thick)
photomultiplier
amplifier

AUGER


Communications antenna
GPS antenna
Electronics enclosure
Solar panels
Battery box
EZRA
3 – nine inch photomultiplier tubes
Plastic tank with 12 tons of water


LOMA AMARILLA
COIHUECO
MORADOS
LEONES
PROYECTO PIERRE AUGER
AREA NIHUIL
RECOPILACION TOPOGRAFICA


© AGASA
J(E) E^3 [m^{-2}sec^{-1} sr^{-1} eV^2]
Energy [eV]
Uniform sources
10
3
6
3
2


J(E)E^3, eV^2 m^{-2} s^{-1}sr^{-1}
E, eV
HiRes I - HiRes II
Akeno - AGASA
Yakutsk
Auger(comb) - Auger(hybr)

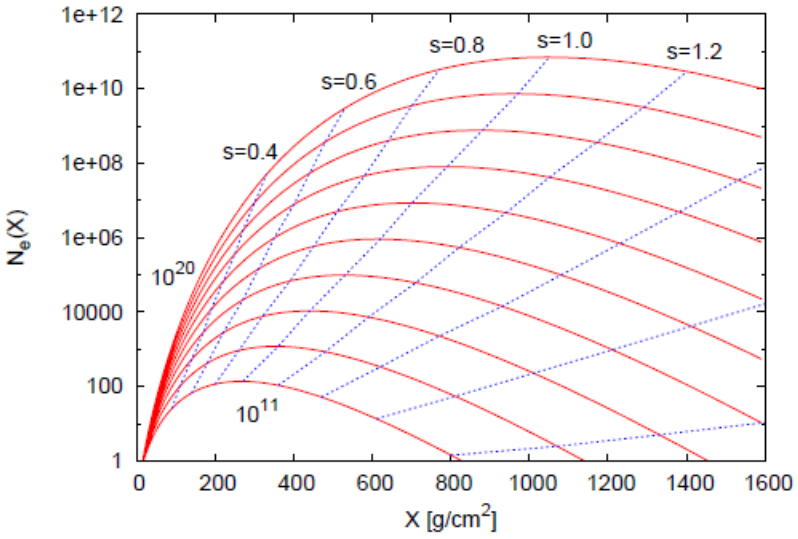
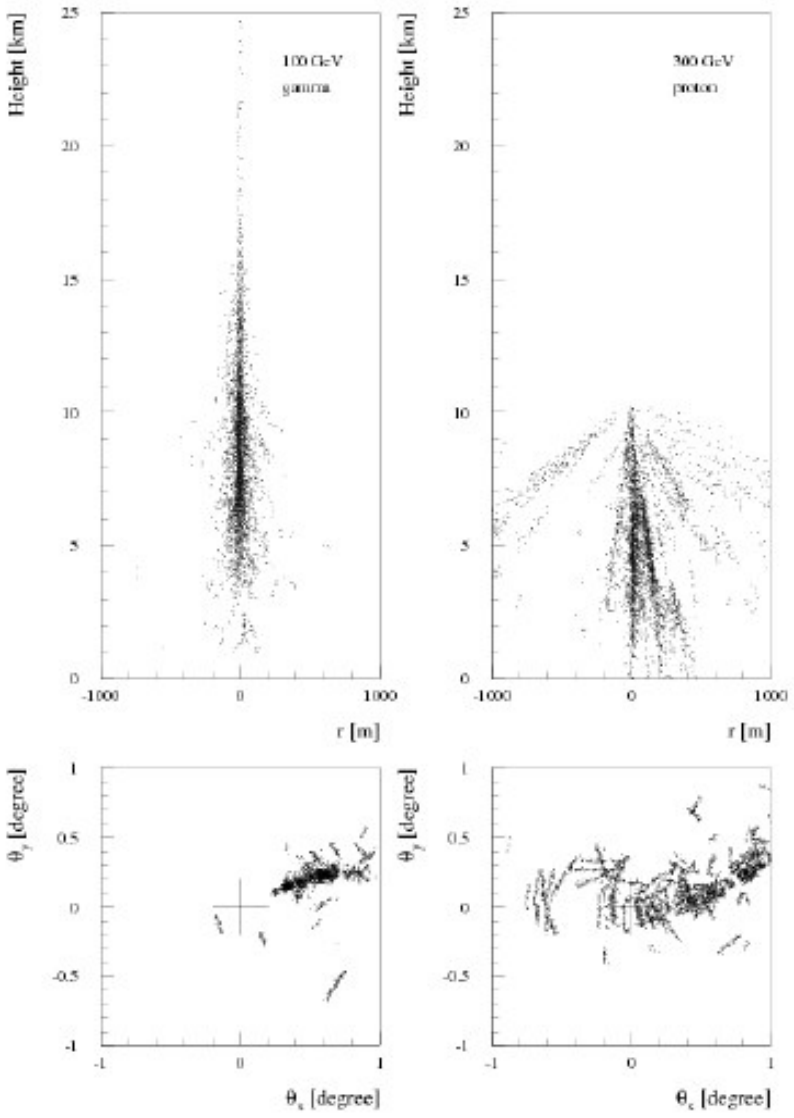


Figure 5.3: Number of electrons $N_e(X)$ in an electromagnetic shower initiated by a photon as function of the depth X for primary energies $10^{11}, 10^{12}, \ldots, 10^{20}$ eV; the shower age s is also indicated.



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