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ASTROPHYSICAL AND TERRESTRIAL NEUTRINOS IN SUPERNOVA DETECTORS

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ABSTRACT

Supernova (SN) explosions are the place of very fundamental phenomena, whose privileged messengers are neutrinos. But such events are very rare. Then, SN detection has to be combined with other purposes. The recent developments of SN detectors have been associated with developments of underground particle physics (proton decay, monopoles...). But here, I will restrict myself to discuss the possibilities for a supernova detector to be sensitive to other sources of neutrinos, astrophysical or terrestrial.

1 - SUPERNOVA DETECTORS

Supernova (SN) explosions are very interesting events, as fundamental physical processes are concerned. For instance, at the end of the gravitational collapse of a star massive enough to give rise to a (type II) SN, the core of the star reaches the nuclear density and becomes a neutron star ; thus, these objects, are, in a way, a unique "laboratory" for nuclear physicists. Note also that it is during such explosions that the heavy elements synthesized during the lifetime of the star are expelled in the interstellar medium ; thus, SN play a key role in the chemical evolution of galaxies.

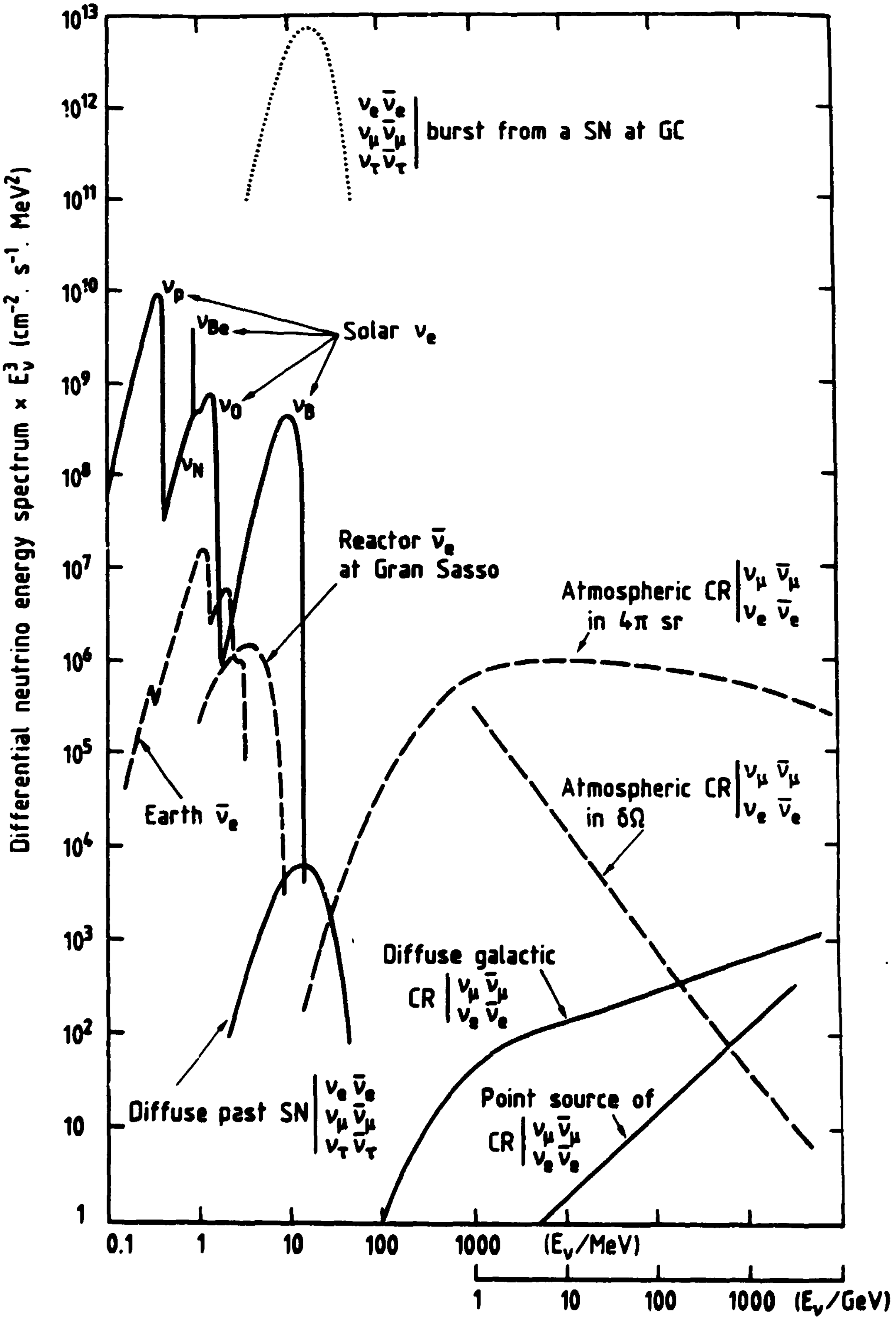
The best way to collect information on these processes is to build neutrino detectors. Indeed, almost all the energy available from the gravitational collapse of the star is evacuated in the form of neutrinos and antineutrinos. Electronic neutrinos are produced first by neutronization ($p + e^- \rightarrow n + \nu_e$) with a characteristic time behaviour reflecting the processes occurring during the collapse (for more details on these neutrinos, see the paper by R. Schaeffer, this volume, and references therein). But the bulk of the gravitational energy is evacuated by pairs of neutrinos and antineutrinos of all flavors, produced during the cooling of the neutron star. A total of $\sim 10^{58}$ neutrinos and antineutrinos, with energy around 10 MeV, is emitted during the several tens of seconds that the phenomenon lasts; then, about 2 10^{11} $\bar{\nu}e/cm^2$ are expected on Earth for one SN exploding in the Galactic Center (GC).

The detection of such a burst of neutrinos and antineutrinos coming from our galaxy is now quite feasible. Of course, as the interaction cross-section of a neutrino is tiny ($\sim 10^{-14}$ mb at 10 MeV), large ($\gtrsim$ 100 tons) detectors are needed. Furthermore, these detectors have to be underground, in order to be shielded against cosmic rays (which could simulate neutrino interactions). Fortunately, such "cosmic ray silent" places are also required for large particle physics experiments like the search for proton decay or magnetic monopoles... , so that several underground laboratories exist through the world ; a veritable underground center is currently being dig into the Gran Sasso mountain in Italy$^{1)}$. The neutrino interaction which is put in evidence most easily, is the interaction of an electronic antineutrino by charged current: $\bar{\nu}_e+p \rightarrow e^++n$, whose threshold is 1.8 MeV. The detection of an electronic antineutrino is easier than that of an electronic neutrino, simply because at low energies, the proton (or neutron), on which an antineutrino (or neutrino) interacts, has to be weakly bound and it is easier,in practice,to find "free" protons than "free" neutrons. The electronic scattering interactions (for instance $\nu_e+e^- \rightarrow \nu_e+e^-$) have a lower cross-section, but have the interesting property of keeping some statistical memory of the arrival direction of the neutrinos.

Several detectors are indeed waiting for a SN explosion. One of the most performant, for the moment, is the Liquid Scintillator Detector (LSD) placed in the Mont-Blanc tunnel$^{2)}$. For about 1 year, 90 tons of liquid scintillator put in 72 containers, each watched by 3 photomultipliers, are waiting for a SN explosion. A few tens of interactions, in a time window of $\sim$ 20 s, are expected from a SN exploding in the Galactic Center. Such a burst is made quite detectable by a correlated detection of the two products of an antineutrino interaction: the neutron and the positron, which permits a better rejection of the non-neutrino background. The detectors have a good energy resolution but no angular resolution. Two other similar detectors exist: the Artyomovsk Scintillation Detector (ASD) and the Baksan Scintillation Telescope (BST)3). A 140-ton Large Area Scintillation Detector (LASD) is almost complete at Homestake4). But up to now, no SN explosions have been seen in neutrinos. This is not surprising.

Indeed, the rate of SN explosions in our galaxy is very low. The exact value is barely known ; an approximate value of one explosion every 30 years can be inferred from photon observations of SN remnants in our galaxy and SN explosions in external galaxies and from the pulsar birthrate (5) and references therein). Of course, detectors sensitive to SN explosions in external galaxies would have a higher detection rate; but prohibitive large detectors ($\sim 10^3$ kilotons) are required in order to increase substantially the rate of detectable explosions. Thus, we have really to deal with a very rare phenomenon. The low rate has two consequences which are somewhat contradictory. On the one hand, a tendency to ask for a great effort in order to have large and sophisticated detectors, capable of collecting the maximum of information when one SN accepts to explode; on the other hand, the fact that this rate is very discouraging. A possible solution to the dilemma is to build detectors able to do something else between two SN explosions.

The numerous large ($\geq$ 1 kiloton) proposed SN detectors stem from the development of pluridisciplinary detectors. For example, proton decay detectors are also neutrino detectors; furthermore, water Čerenkov experiments can have an energy threshold low enough to allow detection of the positrons resulting from SN antineutrino interactions in the detector6). This goal is now explicitly included in the new projects of such detectors7). The same is true for projects on magnetic monopole search8). On the other hand, the detectors more optimized for SN detections (correlated detection of the e^+ and n), as, for example, the 1 kiloton Large Volume Detector (LVD) planned at Gran Sasso9), are also proton decay and monopole detectors. For completeness, I mention the existence of a project of detection of neutrinos from SN by using a heavy water Čerenkov detector and the ambitious ICARUS (Imaging Cosmic and Rare Underground Signals) project, which could detect neutrinos from SN explosions via elastic coherent scattering.


Differential neutrino energy spectrum × E_ν^3 (cm^{-2} . s^{-1} . MeV^2)
10^{13}
10^{12}
10^{11}
10^{10}
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10
1
0.1
1
10
100
1000
(E_ν/MeV)
1
10
100
1000
(E_ν/GeV)
$\nu_e \bar{\nu}_e$ $\nu_\mu \bar{\nu}_\mu$ $\nu_\tau \bar{\nu}_\tau$ burst from a SN at GC
ν_p
ν_{Be}
Solar ν_e
ν_O
ν_B
ν_N
Reactor $\bar{\nu}_e$ at Gran Sasso
Atmospheric CR $\nu_\mu \bar{\nu}_\mu$ $\nu_e \bar{\nu}_e$ in 4π sr
Earth $\bar{\nu}_e$
Atmospheric CR $\nu_\mu \bar{\nu}_\mu$ $\nu_e \bar{\nu}_e$ in δΩ
Diffuse galactic CR $\nu_\mu \bar{\nu}_\mu$ $\nu_e \bar{\nu}_e$
Diffuse past SN $\nu_e \bar{\nu}_e$ $\nu_\mu \bar{\nu}_\mu$ $\nu_\tau \bar{\nu}_\tau$
Point source of CR $\nu_\mu \bar{\nu}_\mu$ $\nu_e \bar{\nu}_e$

Note that I have emphasized here the link between particle physics and SN astrophysics, but the detectors can be used as well for cosmic ray physics, neutrino physics and astrophysics in general.

Another objective for SN detectors is to have the lowest possible energy threshold, in order, once again, to get the maximum information on gravitational collapse, but also in order to take an experimental approach to the problem of SN detection, largely independent of the theoretical predictions. Indeed, if the total energy available from the gravitational collapse is rather well calculated, the mean energy of these neutrinos is much more model dependent. But it is very difficult to reach lower and lower energy thresholds below 10 MeV because the background due to the ambient radioactivity increases very rapidly as the energy decreases. Furthermore, the interaction cross-sections decrease rapidly as the energy decreases; so once again, other purposes have to be found before embarking upon such a work. A possibility is the detection of various continuous sources of low energy neutrinos. In this paper, I would like to discuss the use of SN detectors for the detection of various continuous sources of neutrinos and antineutrinos, whose expected fluxes are sketched on Fig. 1. In Section 2, I consider the astrophysical sources and in Section 3 the terrestrial sources. I conclude in Section 4.

Fig. 1 - Differential energy spectrum expected on Earth from various sources of neutrinos and antineutrinos, times the energy E_ν of these neutrinos to the third power, as a function of E_ν. One can find:

- *a 20 s burst of 10^{58} ν and $\bar{\nu}$ from a supernova (SN) explosion at Galactic Center (GC) (the energy spectrum is from 10)). Such explosions are rare: $\sim 1/30$ yr.*
- *the standard solar ν_e 11) from different reactions of the proton-proton chain: "ν_p" from $p+p \rightarrow d+\nu_e+e^+$, "$\nu_{Be}$" from $^7Be+e^- \rightarrow {}^7Li+\nu_e$ (monoenergetic, so that on the graph the total number of ν_{Be} times E_ν^2 has been represented by a straight line), "ν_B" from $^8B \rightarrow {}^8Be^* + e^+ + \nu_e$ and of the CNO chain: "ν_O" and "ν_N". Note that the flux measured at high energies is 3 times lower than expected 12).*
- *the Earth $\bar{\nu}$ 13).*
- *the $\bar{\nu}_e$ due to far away nuclear power stations, at Gran Sasso 14).*
- *the diffuse continuous SN ν and $\bar{\nu}$ background resulting from all past SN explosions; (the shape of the spectrum is from 15) and the normalisation from 13)).*
- *the atmospheric cosmic ray (CR) ν and $\bar{\nu}$ in 4π steradians and in the best possible angular resolution of the detectors 16).*
- *the diffuse galactic CR ν and $\bar{\nu}$ from 17).*
- *the CR ν and $\bar{\nu}$ flux from the "point" source Cygnus X3 (taken here equal to the gamma flux (18) and references therein), thus minimum).*

2 - CONTINUOUS EMISSION OF EXTRATERRESTRIAL NEUTRINOS

a) SN diffuse background

Another challenge typically in the field of SN detectors is the detection of the diffuse universal SN neutrino and antineutrino background, resulting from all past SN explosions everywhere in the Universe since its beginning. The detection of these neutrinos would bring information on the SN explosion rate averaged over time and galaxies.

Widely different estimates of the intensity of the expected flux exist in the literature, ranging from a "rough guess" of 5 10^3 $\bar{\nu}_e$ cm^{-2}s^{-1} 19) to a conservative value of 1 $\bar{\nu}_e$ cm^{-2}s^{-1} 20). In between one finds 50 $\bar{\nu}$ cm^{-2}s^{-1} 13), $\sim 10^3$ $\bar{\nu}_e$ cm^{-2}s^{-1} 15). And this list is not exhaustive. The differences originate mainly from different values for the rate of type II SN, averaged on time and galaxies. The lower limit of 1 $\bar{\nu}_e$ cm^{-2}s^{-1} is obtained by using the present observed rate. A firm upper limit of $\sim$ 250 $\bar{\nu}_e$ cm^{-2}s^{-1} can be obtained when taking into account nucleosynthetic arguments 20) (the SN cannot have produced more heavy elements than those existing at present). The mean energy of these neutrinos is $\sim$ 6 MeV instead of 10 MeV in the case of one SN explosion because of the expansion of the Universe.

Even adopting the maximum flux of 250 $\bar{\nu}_e$ cm^{-2}s^{-1}, the total number of counts expected during 30 years (the approximate time between 2 SN explosions) is of the same order as the number of counts expected during the 20 s burst from only one SN explosion in the Galactic Center; (but, in one year, the number of counts is low: $\sim$6 events in a 1 kiloton detector). Thus, because the requirements on the background level for a continuous flux are much more stringent than for a burst, it is clear than the detection of the diffuse SN neutrino flux is much more difficult than that of one isolated SN burst. Besides, it is very difficult to disentangle a continuous isotropic neutrino flux from a background, except perhaps from the knowledge of the energy spectrum. But, as we shall see in Section 3, the terrestrial antineutrinos limit the detectable energy spectrum to a narrow window. So, I think that only upper limits could be obtained with the proposed detectors.

b) Solar neutrinos

We have seen that the detection of neutrinos from SN explosions can be a test of the gravitational collapse of a massive star as predicted by the stellar evolution, which is a major theory in astrophysics. Neutrinos can also test this theory for more quiet stars: the low mass stars on the main sequence of the Herstzprung Russel diagramm, which emit continuously electronic neutrinos from the fusion of hydrogen ($4H \rightarrow {}^4He + 2e^+ + 2\nu_e$, via various proton-proton chain).

Although fewer neutrinos are emitted in that case, we are lucky enough to have such a star very near us: the Sun. The bulk of solar neutrinos ($6\ 10^{10}\ \nu_e\ cm^{-2}s^{-1}$), the "$\nu_p$" ($p+p \rightarrow d+e^+ +\nu_e$), have a maximum energy of 420 keV; about 1/10, the "ν_{Be}" (${}^7Be+e^- \rightarrow {}^7Li+\nu_e$), have an energy of 861 keV but $1/10^4$, the "ν_B" (${}^8B \rightarrow {}^8Be^* + e^+ + \nu_e$) have "high energies" up to 14 MeV (see Fig. 1).

Till now, only the neutrinos of high energies ($\geq$ 814 keV) have been detected in the radiochemical experiment of Davis (based on the chemical extraction of the ${}^{37}Ar$ generated by neutrino interactions at the rate of 1 atom every two days, in 133 tons of ${}^{37}Cl$: ${}^{37}Cl+\nu_e \rightarrow {}^{37}Ar+e^-$)[12]. This first and only detection of extraterrestrial neutrinos has led also to a first surprise: the measured flux is 3 times lower than expected from the standard solar model (for more details on this model, see the paper by M. Cassé et al., this volume and references therein).

The next step is to catch some of the numerous solar ν_p as their flux depends very little on the various astrophysical non standard (stationary) models, derived to account for the Davis result. This is the goal of radiochemical experiments based on the reaction ${}^{71}Ga+\nu_e \rightarrow {}^{71}Ge+e^-$, whose energy threshold is 236 keV (for more details on the Ga experiment planned at Gran Sasso, see D. Vignaud, this volume).

The SN detectors are also, in principle, sensitive to the solar neutrinos via electronic scattering interactions ($\nu_e+e^- \rightarrow \nu_e+e^-$). Although, for background reasons, only high energy solar neutrinos are concerned, their detection would be very valuable. First, from general considerations, it would be welcome to corroborate the important result of the Davis experiment by means of another experiment, based on different principles. But the main advantage of SN detectors is that they count neutrinos one by one and they can determine the energy of these neutrinos. As a consequence, the detectors can be sensitive to ν_B only, while the Davis experiment was a bit "polluted" by ν_{Be}. About 1000 interactions per year are exexpected in a 1 kiloton SN detector. But, of course, as the Sun cannot be shut down, the background (due mainly to ambient radioactivity) must be much lower than 1000 events per year; this is a severe constraint but it is worthwhile to try by shielding the detectors against external radioactivity and by using materials with very few radioactive impurities.

c) Neutrinos from high energy cosmic rays

Apart from SN and the Sun, no neutrinos from stars are expected to be detectable in the near future. But another source of neutrinos has to be considered: nuclear interactions of cosmic ray protons (CR) with ambient matter, which produce muonic and electronic neutrinos and antineutrinos of high energies, via the decay of charged pions and muons.

During these collisions, neutral pions are produced as well ; these pions decay rapidly into two gamma-rays. Thus, the sources seen in gamma-rays are prime candidates to neutrino detection. A positive detection would really prove the presence of high energy protons, while the gamma-rays can originate from electron bremsstralhung as well as from proton nuclear interactions. Scaling <u>directly</u> the neutrino fluxes, expected on Earth, from the data on high energy (∿ 1 TeV) gamma-rays (but see the presentation of G. Chardin, this conference, for a critical review of some of these data), one obtains fluxes of the order of 10^{-10} (ν of energy $\gtrsim$ 1 TeV) $cm^{-2}s^{-1}$ <u>or less</u>.

Such numbers are low and huge detectors are needed. A special detector is designed to detect these fluxes: the <u>D</u>eep <u>U</u>nderwater <u>M</u>uon and <u>N</u>eutrino <u>D</u>etector (DUMAND). In this project, an array of 756 phototomultipliers, located at 5 km under sea-water, detect the

Čerenkov light of muons produced during neutrino interactions with water. The array will cover a volume of 0.03 km^3 but the effective volume should reach 0.5 km^3 for 2 TeV neutrinos. The effective volume is greater than the real volume because muons generated outside the detector by neutrino interactions can reach the detector. (The range for electrons is much less than for muons; that is why only muonic neutrinos (and antineutrinos) are considered). An energy threshold of 2 TeV is optimum from considerations on the atmospheric CR neutrino background (see Sect. 4), angular resolution, interaction cross-section, effective volume. The minimum detectable flux is $2\ 10^{-10}$ (ν of energy > 2 TeV) $cm^{-2}s^{-1}$. The angular resolution is 1°. (For more details on DUMAND, see the paper by P.Grieder, this volume).

SN detectors are also detectors of high energy neutrinos. But they are at least three orders of magnitude smaller than DUMAND. Note that when we consider the effective volume, the difference reduces to two orders of magnitude. Up to now, we have considered only thin gamma-ray sources. But it is quite possible that part of the gamma-rays have been absorbed in the vicinity of the source or during their propagation to the Earth, while the neutrinos thanks to their tiny cross-section escape freely. That is what makes the detection of CR neutrinos so attractive. It is very difficult to estimate quantitatively the neutrino enhancement with regard to gamma-rays from such absorbing regions. The best thing to do is to wait and see (if lucky).

3 - TERRESTRIAL NEUTRINOS

It is not necessary to go very far away to find interesting sources of neutrinos; just above our heads, cosmic ray interactions with the atmosphere generate plenty of neutrinos and antineutrinos; around us, the nuclear power-stations are powerful sources of electronic antineutrinos; under our feet, the Earth itself is a source of electronic antineutrinos.

a) Atmospheric CR neutrinos

Almost all the cosmic rays entering the Earth atmosphere undergo nuclear interactions; indeed, the grammage in the atmosphere is much higher than the CR interaction length ($\sim$ 150 g cm^{-2}), while the mean geometrical grammage in the galaxy is only of 3 10^{-3} g cm^{-2}. Thus, the mean diffuse neutrino flux originating from CR interactions in the galaxy is completely dominated by atmospheric CR neutrinos, even though the galactic CR neutrino energy spectrum decreases less rapidly with energy than atmospheric neutrinos (see Fig. 1). The detection of "point" sources is easier, at least at high energies. Indeed, even if the fluxes are somewhat lower than the diffuse flux, the atmospheric background, which has only to be taken in a small solid angle, is much lower (see Fig. 1). This is true only at high energies because otherwise the products of a neutrino interaction (by charged current) do not keep memory of the arrival direction ot their parent.

The atmospheric neutrinos are also a poison for proton decay experiments. About 100 events per year and per kiloton have been measured in agreement with the calculations. Some of these events look like proton decay events, making ambiguous the identification of eventual proton decay events ($^{21)}$ and references therein).

A positive use of these atmospheric neutrinos is the study of neutrino oscillations at the scale of the Earth diameter ($^{22)}$ and references therein). But <u>matter</u> oscillations in the Earth, complicate very much the interpretation of the data$^{23)}$.

b) **Earth antineutrinos**

The Earth itself is continuously emitting electronic antineutrinos via the β decay of isotopes in its lithosphere (^{238}U, ^{232}Th, ^{87}Rb, ^{40}K). These antineutrinos have a maximum energy of 3.3 MeV and a total flux of $\sim 10^7$ $\bar{\nu}_e$ cm^{-2}s^{-1} $^{13)}$. Their detection, which would bring a direct knowledge of the heat flux inside the Earth, should be of interest for geophysicists.

As the energy threshold of the reaction $\bar{\nu}_e + p \rightarrow n + e^+$ is 1.8 MeV, the detection of the high energy tail of Earth antineutrinos is theoretically possible with SN detectors. With such a low threshold, a 1 kiloton SN detector should detect about 50 events per year; but the background due to the ambient radioactivity, becomes more and more critical as the energy threshold decreases, making the detection of the Earth antineutrinos hypothetical. Furthermore, in some places, the antineutrino background due to nuclear power stations completely dominates the high energy Earth antineutrinos (see below).

c) Nuclear reactor antineutrinos

Another antineutrino background, but this time man-made, is due to all the nuclear power stations on the planet; 345 reactors were in operation on December 1st 1984 (see Fig. 2 for their geographic distribution in Europe). Indeed, apart from being powerful energy sources, the nuclear power stations are powerful sources of electronic antineutrinos with energies up to ∿ 10 MeV, produced during the β decay of the fission products (^{235}U, ^{238}U, ^{239}Pu, ^{241}Pu). The set of nuclear power stations generate a background which depends of course on the point on Earth considered and varies from $4\ 10^4\ \bar{\nu}_e\ cm^{-2}s^{-1}$ at Kolar Gold Field to $3\ 10^6\ \bar{\nu}_e\ cm^{-2}s^{-1}$ at the Frejus or Mont Blanc tunnel; it is in between at the Gran Sasso laboratory: $4.5\ 10^5\ \bar{\nu}_e\ cm^{-2}s^{-1}$ 14),24).

This background has several negative aspects (see Fig. 3):
i) it prevents from having access to the diffuse SN antineutrinos below ∿ 10 MeV;
ii) it also may have to be taken into account in the projects of detection of solar neutrinos by SN detectors. Indeed, in most underground laboratories, reactor antineutrinos dominate solar neutrinos below a certain energy which depends on the location of the laboratory (for instance 4 MeV at Gran Sasso). Then, the detectors have to be able to distinguish between antineutrino and neutrino interactions;
iii) at last, it should influence the choice of the location of future Earth antineutrino detectors. Indeed, in most present laboratories the reactor antineutrinos represent 10% of the Earth antineutrinos. In one laboratory (Fairport Harbor), it will become soon even higher.

A possible positive use of the reactor antineutrinos in SN detectors is the study of neutrino oscillations. The idea of using reactor antineutrinos to study neutrino oscillation is not new; besides, several small (∿ 0.3 ton) detectors are located at a few

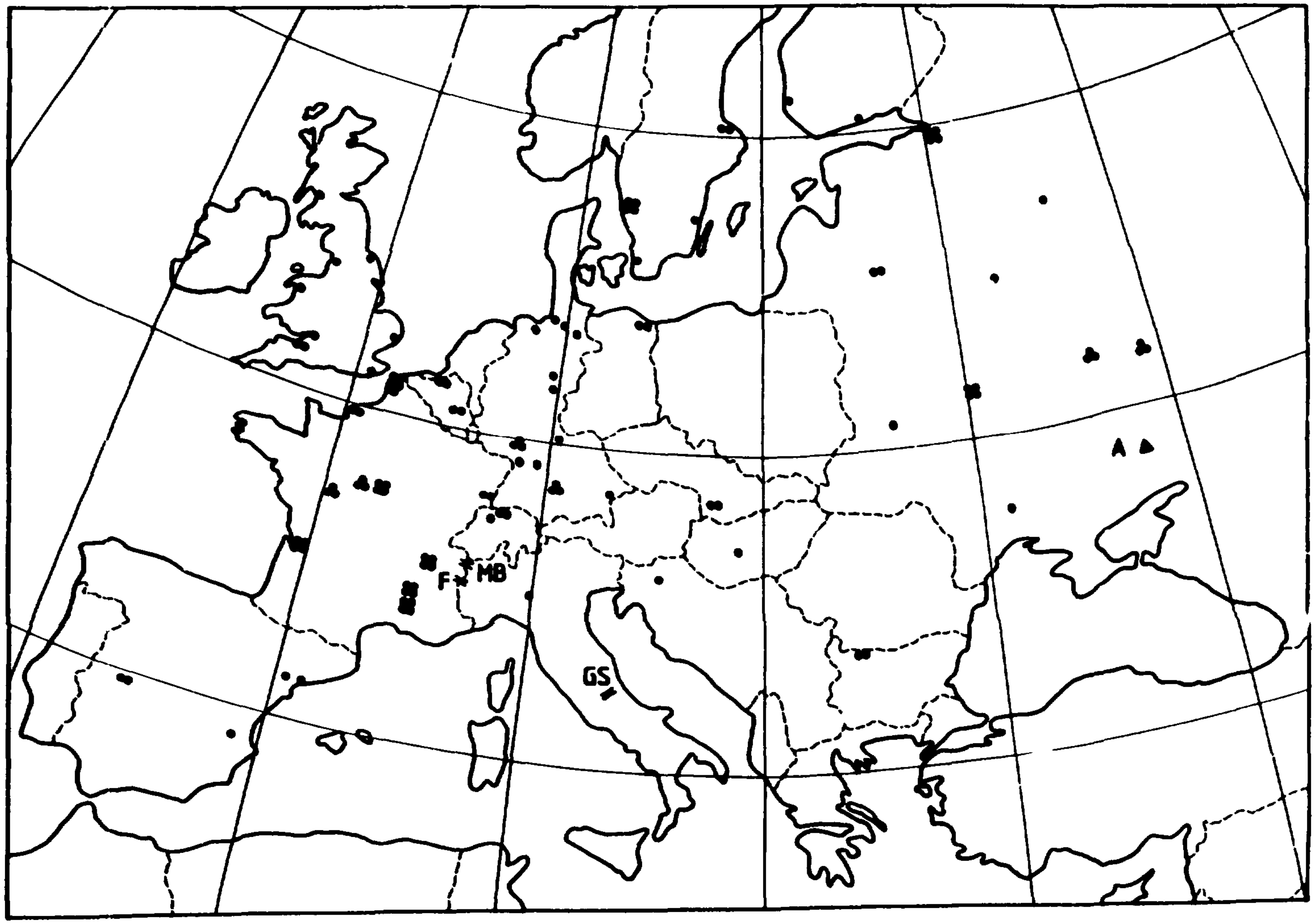


Fig. 2 - Distribution of nuclear power stations in Europe, on December 1st 1984 (from the ELECNUC data bank (DPG, CEA)). The number of points indicates the nuclear power available in unit of GWe; places with power lower than 0.5 GWe are not indicated. Various underground laboratories have been indicated (A for Artyomovsk, F for Frejus, MB for Mont-Blanc, GS for Gran Sasso).

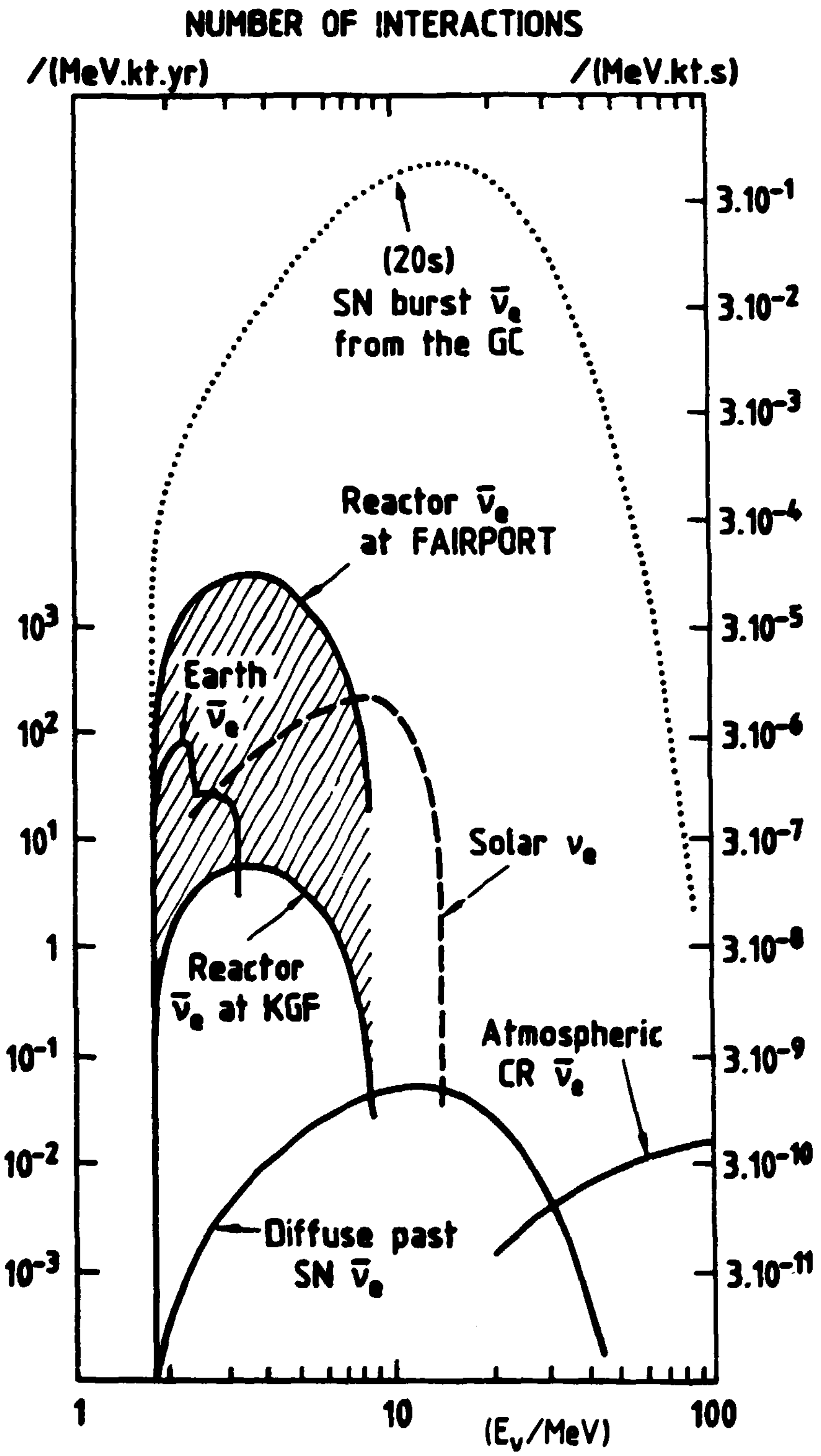


Fig. 3 - Energy spectrum of neutrino or antineutrinos expected per year (or second), from various sources, in a 1 kiloton scintillator detector (from 14) and references therein). The 2 curves for reactor $\bar{\nu}_e$, correspond to 2 extreme cases; the laboratory, located at Fairport Harbor (IMB experiment) will be soon the laboratory having the highest reactor $\bar{\nu}_e$ background, while the laboratory at Kolar Gold Field has the lowest one.

tens of meters from nuclear reactors (25) and references therein). It seems to me natural, a priori, to use also the big SN detectors for this purpose. But although the SN detectors will be 3 10^3 times bigger that the detectors near reactors, the fluxes in present laboratories are at most of 3 10^6 $\bar{\nu}_e$ $cm^{-2}s^{-1}$; that is 10^5 times lower than at 100 meters from a typical nuclear reactor; so that the statistics will be very low. Furthermore, these antineutrinos originate from several nuclear power stations, which are not in operation at the same time; so that it will be difficult to disentangle neutrino oscillations, if any.

These inconvenients can be, at least partly, circumvented at Fairport Harbor laboratory. Indeed there is a nuclear power station under construction at 10 kilometers from the laboratory. A 10 kiloton SN detector located there, would have as much as antineutrino interactions as the small oscillation detectors very near (100 m) reactors. Then, neutrino oscillation could be studied with an oscillation length 2 orders of magnitude larger than at present. The previous estimates assumed that the energy threshold was as low as 3 MeV, and that the background was low enough to make possible such a threshold, which is an ambitious objective.

Note that instead of putting SN detectors near nuclear power-stations, another possibility would be to put reactors near SN detectors.

CONCLUSION

Neutrino astrophysics is very promising. Neutrinos are privileged messengers of phenomena occurring in dense regions (core of the Sun, SN...), while the electromagnetic radiation is rather concerned with "surface phenomena".

But the detection of these neutrinos is difficult. The possibility of working out pluridisciplinary detectors has really prompted the start of numerous projects. This is particularly true for SN detectors, which are also proton decay and monopole detectors (and vice-versa).

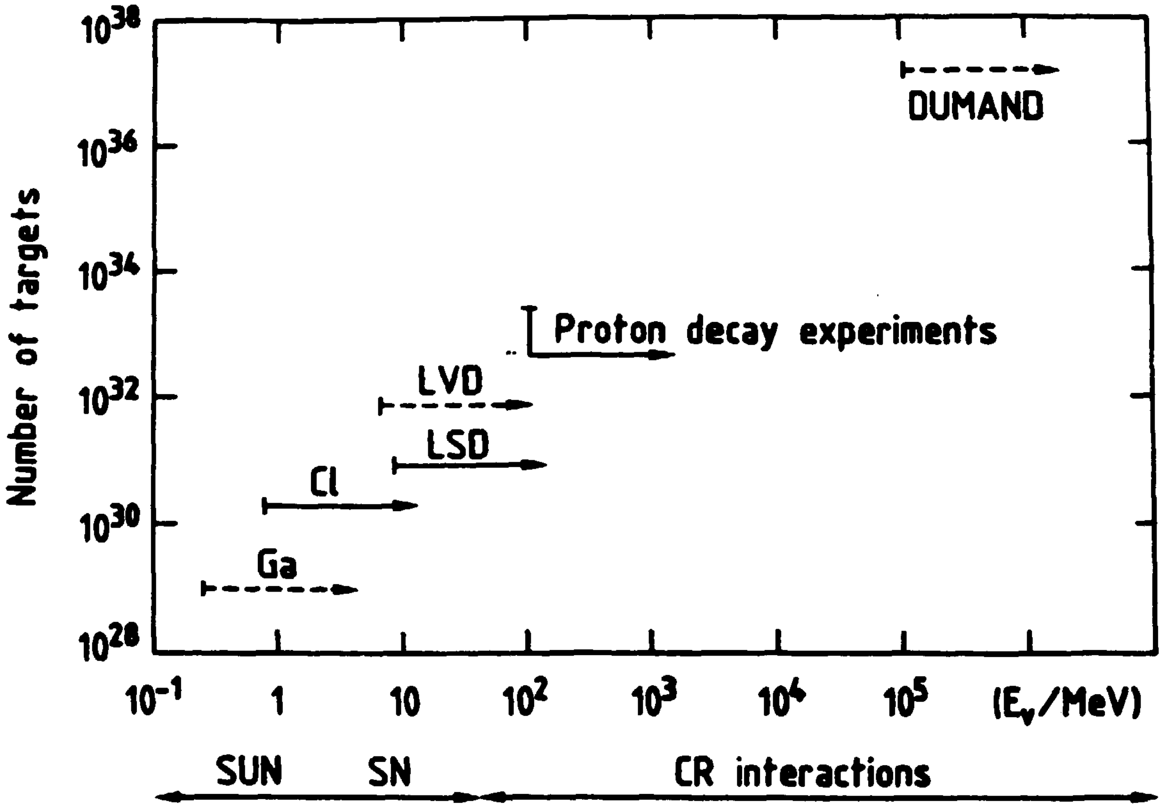


Fig. 4 - Number of targets for various typical neutrino detectors (in operation full line; proposed dashed line) in different energy ranges.

If we consider only neutrinos, apart from SN neutrino bursts, the SN detectors could be sensitive to high energy neutrino sources with large neutrino over gamma-ray ratio, to high energy solar neutrinos and their energy spectrum, and to reactor antineutrinos and their possible oscillation. In the last two cases, a careful study of the background is necessary before concluding about detectability. Of course, the detection of unexpected sources is always possible and past astronomy experience has shown that surprises are frequent when new windows are open.

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