



## **Workshop on Atmospheric Electricity and Ions - Influence on Health and Comfort, WHO, Copenhagen, 11-12 Dec. 1986**

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## **Highlights of the Workshop**

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### **A. Characteristics of Ions and Fields**

- 1. Coupling*
- 2. Mobility*
- 3. Air conductivity*
- 4. Charge*
- 5. Density*

### **B. Ions Generation & Depletion Mechanisms**

- 1. Small ions outdoor sources*
- 2. Fluctuation*
- 3. Small ions indoor*

### **C. Ions & Fields, Mythology vs. Reality**

- 1. Dust and viruses removal*
- 2. Charge neutralization*
- 3. Effects of ions on human*
- 4. Air cleaning processes*

### **D. Recommendations for Future Research Work**

## A. Characteristics of Ions and Fields

### 1. Coupling

As pointed out by N. JONASSEN, *ions & fields* are closely interrelated. Several effects which have been attributed in the past to ions should be more closely investigated before ruling out an effect of the electrical field alone. The static field which always accompanies ions can indeed be generated separately.

### 2. Mobility

Three parameters characterize small ions:

- their total number  $n = n^+ + n^-$
- the ratio  $r = n^+ / n^-$
- their mobility  $k$ .

As the mean free path in air limits the actual time during which ions are accelerated by external static fields, the result is an average constant velocity  $v = k \times E$ , where  $E$  is the electric field strength, and the proportionality constant  $k$ , the mobility.

Small negative air ions or *negions* show a mobility  $k^- = 1.8 \times 10^{-4} \text{ [m}^2 \text{ V}^{-1} \text{ s}^{-1}\text{]}$

slightly higher than that for posions:  $k^+ = 1.3 \times 10^{-4} \text{ [m}^2 \text{ V}^{-1} \text{ s}^{-1}\text{]}$

Therefore, as ions are produced in nature by pairs, the natural equilibrium ratio  $r_0$  tends to be slightly larger than unity, while, in transient situations, the reverse occurs.

### 3. Air conductivity

Air ions appear as a quantized mass-spectrum with strongly varying intensity mass levels (possibly of *modulo 18 AU*, i.e. additional water molecules).

The exact chemical nature of ions is not known and is intrinsically elusive.

Negions could be  $O_2^-$ ,  $N_2^-$ ,  $CO_2^-$  in various stages of hydration.

Large air ions are very slow and tend to shield the static field in which small ions are moving.

The air conductivity is nearly exclusively *due to small ions*,

because the mobility of *large ions* is typically  $10^{-7} \text{ [m}^2 \text{ V}^{-1} \text{ s}^{-1}\text{]}$ ,

i.e. one thousand times less than the one of small ions.

### 4. Charge

The smaller is the mass of an ion, the smaller is the chance than it would obtain a multiple charge.

One can therefore assume that a negion has *only one extra electron*.

### 5. Density

To measure the number of ions in a volume of air, one has to detect an exceedingly small current, e.g.  $10^4$  ions yield only 1 fA (femto =  $10^{-15}$ )

## B. Ions Generation & Depletion Mechanisms

### 1. Small Ions' Out-door Sources

- Radioactive gases (mostly Radon) emit  $\alpha$ -particles which have a strong ionizing power, producing up to 200,000 pairs ( $n^+$ ,  $n^-$ ) in air.
- Cosmics rays
- Solar UV-radiation ionises atoms by photoelectric effect.

The Earth surface is negatively charged. It attracts the posions from the ionosphere which would neutralize its charge *within an hour* in the absence of a replenishing effect: the thunderstorms. Those are bringing, 9 times out of 10, negative charges back to Earth's surface. This numerous negative charging current appears to keep in check the neutralization due to the attraction of posions.

## 2. Fluctuation

In out-door air, *man-made* pollution strongly affects  $n$ , the total number of small ions.

The small ions population is depleted because they attach to aerosols and then become large ions. During the winter, the emission of smoke from the heating systems bring  $n$  to a minimum. However, the enforcement of environmental laws in matter of yearly control of domestic and industrial burners has brought (e.g., in Aarau, Switzerland) a net effect. In Frankfurt, FRG, Betatrons (electron accelerators) are used on industrial chimneys to precipitate the  $SO_2$  pollution .

In industrial cities, like Aarau, in addition to the seasonal cycle [**Fig.1**], appears also a weekly cycle [**Fig.2**]. The measurements of Leonhard SAXER reveal a drop by a factor of two for  $n$  during mid-week, while a resplenishment occurs during the weekend. Daily cycles are also noticeable. L.SAXER related them with the fluctuation of the road traffic around the building where the measurements are taken.

Man-made pollution can exceptionally, as revealed by the Aarau's data of May 1st 1986 [**Fig.4**], induce a tremendous increase of  $n$  (up to 4'000/cc).

Wind, by diluting the pollution can also enhance the number of small ions. In such transient situation, as the mobility  $k^-$  is higher than  $k^+$ , the ratio  $r = n^+/n^-$  (in both case of foehn and Chernobyl's dust clouds) takes, in Aarau, a value smaller than unity.

## 3. Small Ions In-door

- Ions density is usually restored, after a perturbation, within 2 to 4 minutes.

- Buildings materials, specially **granite**, contain traces of radioactive elements releasing Radon gas. An under-pressurized dwelling tends to act as a pump for Radon.

- Artificial unipolar sources take advantage of the very high electrical field at the end of a needle (corona effect). The simultaneous highly undesirable production of ozone by corona effect grows quadratically with the applied high voltage. Therefore a tension of 8 kV seems to be a maximum value in order to keep reasonably high ions production and acceptably low ozone levels. The artificial sources can be classified into 2 groups:

### i) open field

The ions are attracted by any static field present. As in 80% of cases the floor's charge is negative, regions will be attracted by other surfaces, like walls. Such charged dielectrics might become neutralized after a while and even followed by an *overkilling*: the field polarity will become opposite.

### ii) closed field

A bias polarity of opposite sign is applied to a nearby conducting *collector* surface. Unshielded Video display terminals will create on the nose of the operator a field attracting loaded air-borne pollutant of opposite charges, inducing rash and skin disease.

## C. Ions& Fields: Mythology vs. Reality

### 1. Dust and Viruses Removal

Effectiveness of small air ions in removing pollutants of small granulometry (10-100 nm) is not under question. Infection propagation has been investigated for chicken by G. GRAEFFE: in presence of open field ion production, the viruses have not been transferred between animals.

Effectiveness of closed field regions generators can be observed by the rate of dust deposition on the *collector*, for the large sizes. For viruses and bacteria, tests with *plates* are mostly contradictory because an *overkilling*, repulsing effect is hard to control. Therefore, experiments such as the above mentioned chicken' test are more meaningful. Ions most probably induce the *deposition* of bacteria onto surfaces *rather than bacterial death*. Therefore in some situations, ionizers might be *hazardous*, e.g., in an operating theatre, deposition of live organisms onto surfaces is more dangerous than when they are airborne.

## 2. Charge Neutralization

- For *isolators*, charge neutralization is best achieved by grounding.  
- For *dielectrics*, ions are quite effective (with the risk of overkilling if a unipolar ionizer is used). AC ionizers are successfully used in many industrial applications to remove surface static charge. Humidity and spraying also helps in the sense that a thicker water layer on a dielectric increases its conductivity.

It is common belief that cars tend to get charged by driving. This is nevertheless no longer the case since the admixture of Carbon particulates in the rubber of the tyres. The shock experienced by some people after getting out of a car comes from their own charging by clothes, rubbing against the car's seat while getting out, discharging to earth through the metallic car.

The depletion of air ions in the driving cabins of cars and trucks is therefore a myth, and car-ionizers appear to be typical useless gadgets. Anyway, it seems that trucks accidents do mostly occur *after one to one and a half hour drive* and NOT after 10 hours as currently believed. The beneficial effects of ionizers in reducing driver fatigue is therefore questioned.

## 3. Effects of Ions on Humans

It should never be overlooked that ionizers produce also other things than ions !

### *Fresh Air Feeling*

It might well be that the feeling of fresh air expressed by people when ionizers are in operation is produced by the minute release of ozone.

### *Foehn induced Headaches*

Contrary to a common belief, the foehn, as other winds, produces an increase in small ions and therefore a surplus of negions, as their mobility is higher than posions. Therefore the pressure changes should be more likely responsible for *witches winds* effects

### *Full Moon*

ARRHENIUS (Nobel prize 1903), suggested that biorhythms are related to lunar magnetic tides effect, but the involved biological mechanism is still unknown. On the other hand, posions have been found (in controversial research works) to inhibit the catabolism of the serotonin, a neurohormone responsible for various biorhythms, including menstruation. Therefore Charles WALLACH suggested that a kind of *ions tidal effect* might occurs, a *lunar dimple*, compressing posions toward the earth surface [Fig.3]. Although this model seems to contradict the results of the Appolo mission where no negative charge on the surface of the Moon has been found, the effect of such an hypothesis can at least be tested against ions density measurements:

The Aarau's data collective over a 5 years period, selected to minimize man-made effects (i.e. between 1 a.m. and 2 a.m.), have shown that **no posions increase** can be detected during *full moon zenith* [Fig.4]. Even data taken during a lunar eclipse failed to exhibit any effect [Fig.5]. Full moon ion effect turns out so far to belong to mythology.

### *VODS (Video Operator Display Syndrome)*

Apart from the skin rashes on the nose and face, the retarded VODS effect (after one year) is more probably due to stress and monotony than ions depletion.

### *DC-Fields*

For humans in motion, a DC-field might become a low frequency field and have synergetic effects, therefore it is important to measure all parameters

### *Biological Effects*

Biological Effects of Negions and Posions are very controversial. Though it is obvious than small ions have a very significant effects on plants, the *serotonine syndrome* (activation of serotonin) has never been confirmed in man and seems therefore to belong to mythology.

The fact that small ions are highly unlikely to penetrate the respiratory tract forces to consider with the highest scepticism any report on biologically beneficial or detrimental effects of ions. Nevertheless one can not exclude that effects are caused by surface (skin) effects, an hypothesis which needs further study. Skin polarization might indeed affect the cell membrane potential. Charging test-person with electron accelerator might be worth investigation.

#### 4. Air Cleaning Processes

In rooms with heavy smoking, negion generators have very efficiently superseded conventional air cleaner by reducing the energy consumption by a factor of 1000. According to L. HAWKINS, passive settling of the pollution due to 4 cigarettes in a close room ( $4 \times 3 \times 2 \text{ m}^3$ ) reduces the airborne contamination by 80% in 30 minutes, while an open field ionizer boost this decrease down to 50%.

It is interesting to note that, while ions generators perform far better than most conventional devices in close rooms, the most efficient smoke removal process found so far (Cf. *NEW SHELTER*, Rodale Press Inc, Emmaus, Penn. USA, issue of July 1982) is a portable, noisy circulation fan, worth US\$57, removing all (100%) smoke from a room with open door in less than 6 minutes (25% in less than 40 seconds). In close room, it is less efficient but act somewhat like open field ion generators: it blows particules against the walls, where they stick...

#### D. Recommendations for future research work.

For studying biological effect on humans, it is essential to keep in mind that the potentially sick person should also be studied and not, as it is usual for comfort studies, only the healthy *standard* person.

The cost of absenteeism to the economy is so important that any other benefits of ions generators (like energy savings, etc) are negligible. Any influence on the mobility of bacteria and viruses carried by particulates is, in this respect, very interesting. It seems also important to expect *combined effects* and therefore to record all the parameters, physical, as well as biological, i.e.. to use for ions experimental works a dedicated comprehensive reporting format.

The design of efficient and easily cleanable collectors for closed fields ions generators is very important, as well as the development of smart new sensors (cheaper and more flexible).

Summer schools for atmospheric electricity and related parameters should be organized.

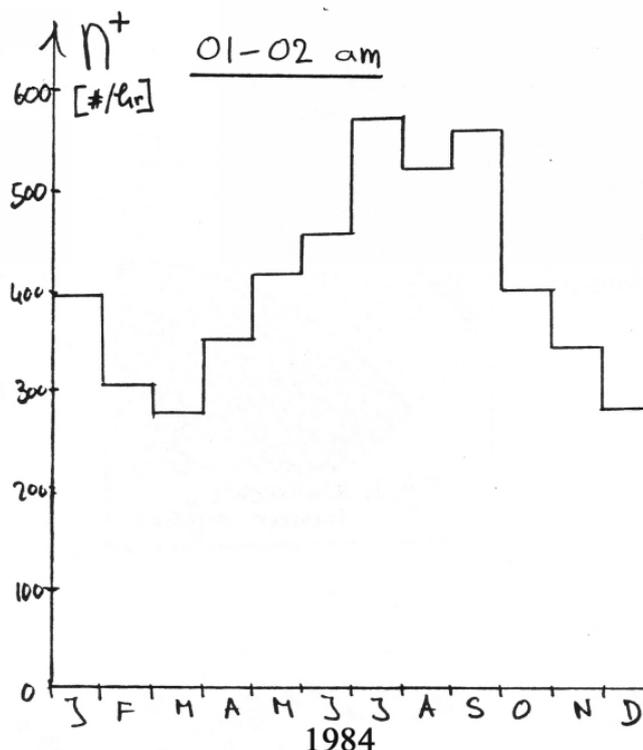


Fig. 1 Seasonal fluctuation in posions

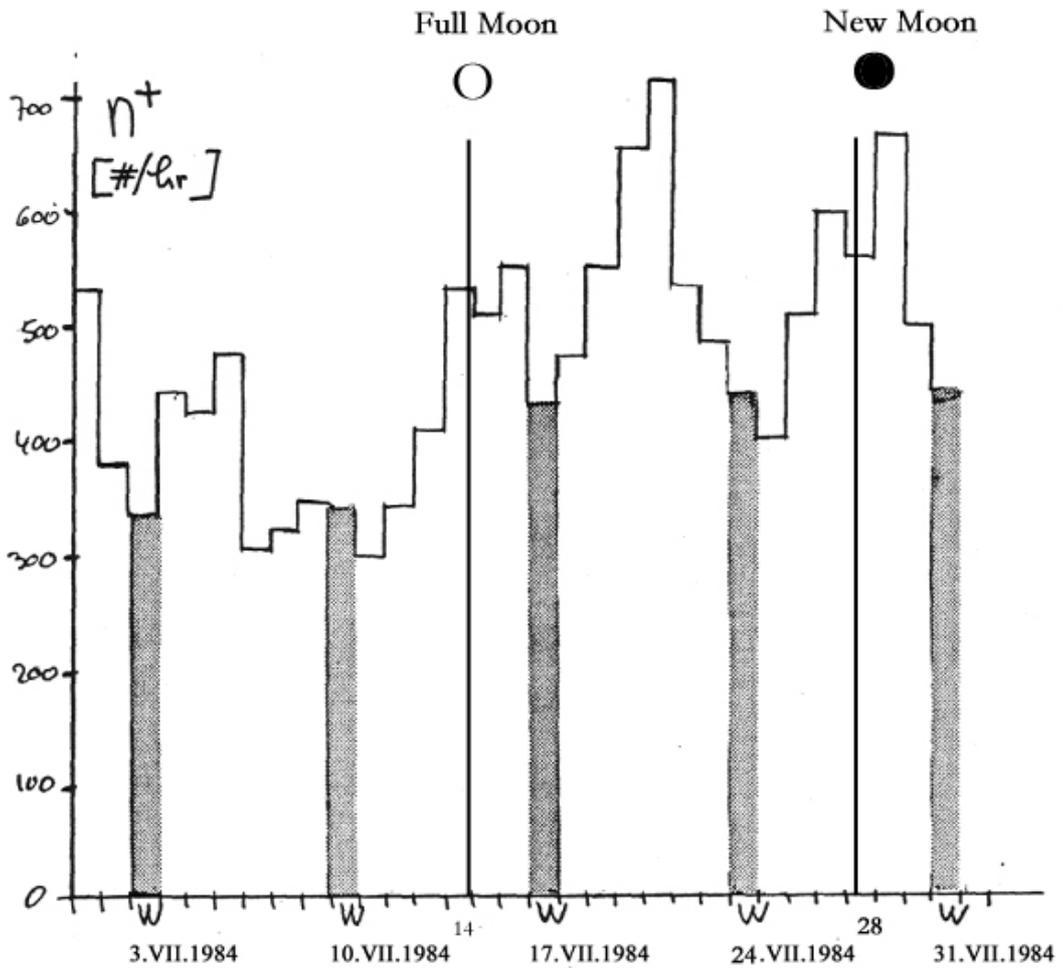


Fig.2 : Weekly cycle for posions

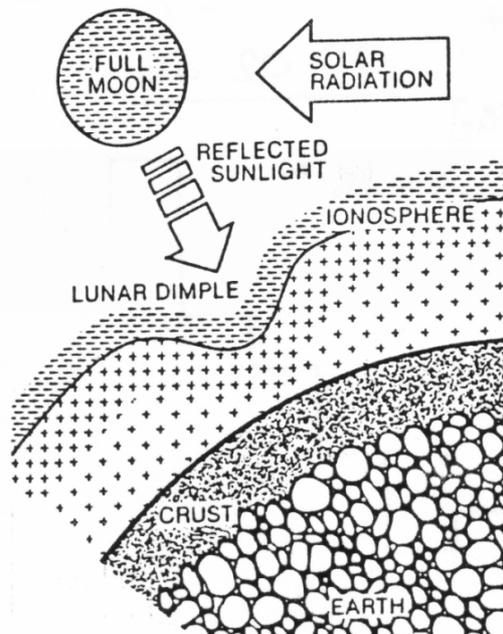


Fig 3: WALLACH's Lunar Effect

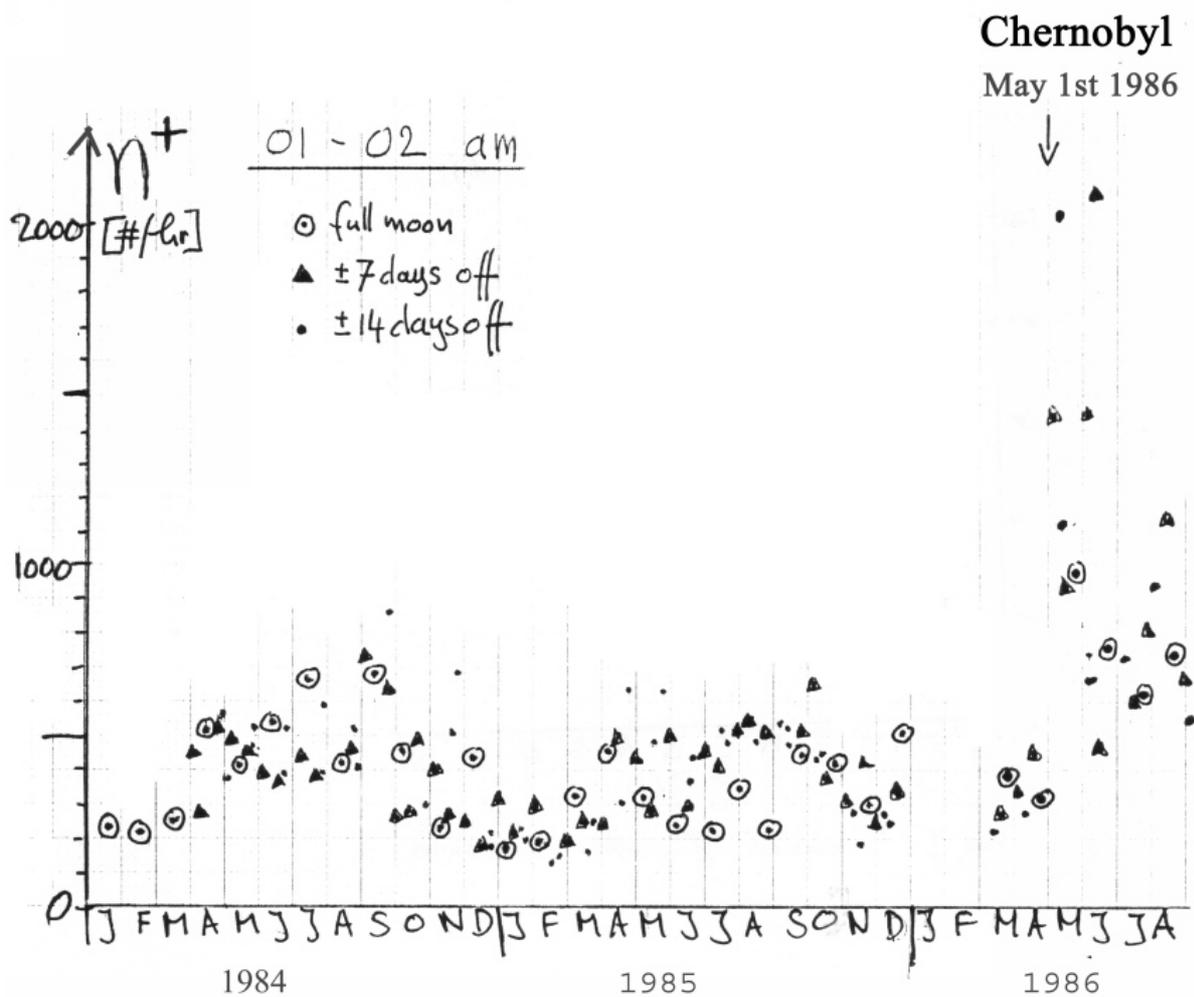


Fig.4 Search for Full Moon Ion Effect and Detection of Nuclear Catastrophe

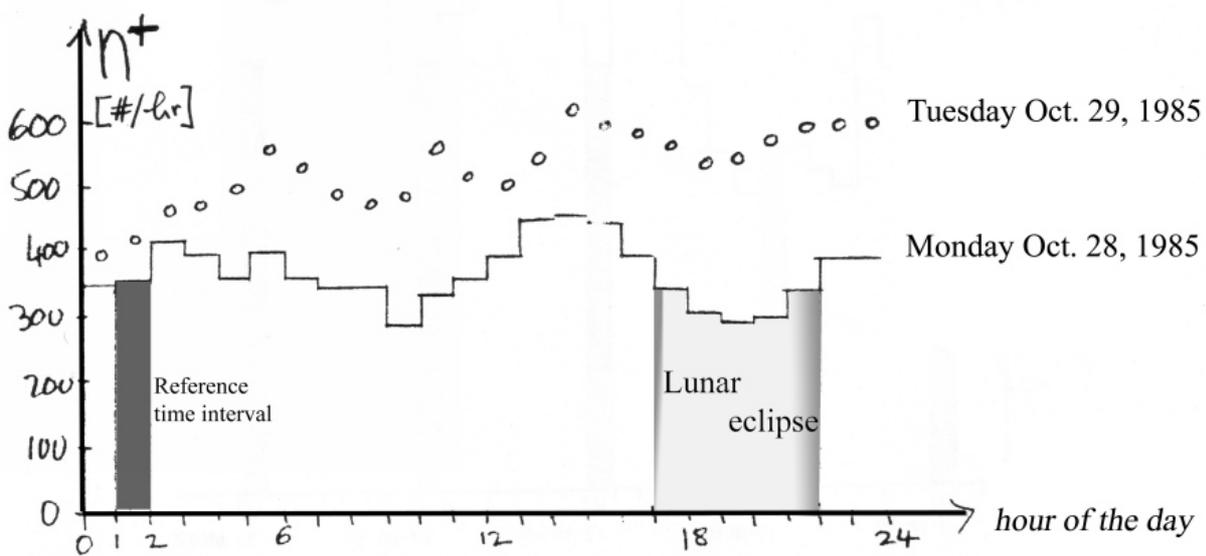


Fig.5 Further Search for Full Moon Ion Effect