SGHA Articles

Expanding knowledge through disseminating information

Ions and ghosts

For a ghost to interact with it's environment it must have some sort of energy source to draw from. One potential hypothesis is that they are utilizing ions for this purpose. An ion is an atom, group of atoms, or subatomic particle with a net electric charge. The hypothesis bears merit based on several factors.

** The human brain uses ionic energy for many of its functions. It is a power system that the "ghost" would be familiar with.*

** Ions can carry energy.*

** Electromagnetic fields interact with ions. Such an interactions are the foundation for EPR spectroscopy.*

** Ions are readily availble in the enviroment.*

General information about air ions

Almost all "+" natural ions come from radioactivity. About 40% of natural air ions come from radioactive minerals in the ground. Each time a radioactive atom decays near the air, it produces 50,000 - 500,000 air ion pairs. Another 40% comes from radon in the air (which produces about 250,000 ion pairs for each radon atom), and 20% comes from cosmic rays (high-energy protons from distant supernovas). Indoors, ions "live" on average about 30 seconds before touching a surface and shorting to ground. Outdoor ions usually "live" several minutes. Negative ions come from radioactivity and evaporating water. Also lightning, thunderstorms, and forest fires contribute "+" and "-" ions, but since these ions are not produced during fair weather, it is usually only radioactivity and evaporating water that produce ions outdoors. Normal fair-weather ion concentrations are 200 to 800 negative and 250 to 1500 positive ions per cubic centimeter. Indoor levels are usually lower. Several hours before a storm, + ion concentration will increase dramatically, sometimes exceeding 5000 ions/cm3 During a storm, - ions increase to several thousand while + ions decrease, often to below 500.

Because a large concentration of + ions can attract - ions, high concentrations of + and - ions are often found together. Typically, a high concentration (1000 or more) of both may be found in one area outdoors while low concentration (300 or less) is found typically one city block away. A cloud of pure + ions (no -) with a concentration of 1000 ions/cm3 would be very unstable and would fall apart if its diameter were more than about 30m (100'). For this reason, high concentrations of exclusively + (or exclusively -) ions tend to be compact, and don't extend more than about 30 m. While testing indoors, you may find high - in one area of a room and high + in another.

The life time of "fast" ions (these are the most common type) is determined by how long they last before they collide with a solid (or dust) which usually neutralizes their charge. Indoors electric fields are stronger than outdoors. Plastic surfaces charge to a typical potential of negative 1000 volts. This produces electric fields of 500-5000 volts per meter near the plastic surface. The electric field repels negative ions (air molecules with an extra 0- or 0H-. The mobility of fast - ions is about 1.2x104 m/s per V/m, so at 2000 V/m, - ions are repelled at a speed of 2000x 1.2x10~4 =.24m/s (meters per second). Positive ions (air molecules with an extra H+ or positive ammonia molecule) are attracted to the plastic by the same field. Their mobility is slightly lower (about 1.0 x 10-4 m/s per V/m) and they have a slightly slower speed of .2 m/s. When the + ions touch the plastic, they give up their + charge. This partially neutralizes the - charge on the plastic. Under typical conditions, complete neutralization of the -charge on the plastic would occur in a few weeks. However, dust blowing by will rub against the plastic and acquire a + charge. This dust carries the + charge away (ultimately to Earth ground). As a result, the plastic always retains a negative charge.
A good way to standardize (and lengthen) the lifetime of indoor ions is to put them in a large cardboard box. Lifetime then is about 50 sec, regardless of humidity, so if, for example, 4 pCi/L of radon is in the box, it will produce a continuous 1600 + ions/cm3 in the box.

You can produce negative ions directly by combing your hair with a plastic comb. If you then blow air past the comb, the air will have between 1000 and 10,000 - ions/cm3 immediately next to the comb. The number is lower in high humidity. Also, your breath contains about 20,000 to 50,000 - ions/cm3 from the

number is lower in high humidity. Also, your breath contains about 20,000 to 50,000 + ions/cm3 from the evaporating water, but you must be grounded to exhale a concentration this high. If you are insulated from ground, you will become more positively charged with each exhalation (by about 5 volts) because your breath is removing negative charge. Eventually, you will become sufficiently positive (after exhaling about 20 times), that the negative ions will immediately return to you. This is the same effect that occurs in building cooling systems that use an evaporating water tower. If not properly grounded, the water pump and vents will become very positive. (If the inside vents are isolated from the evaporating water via a heat exchanger, the vents may become very positive and produce a large number of + ions. This can be corrected simply by grounding the vent).

Both + and - ions come from combustion (flame, wood burning, cigarette smoke, and car exhaust) and from very hot surfaces (hot enough to glow).

Indoors, near ground level (basement), most "+" ions come from radon, and a reading of 1000 "+" ions/cm3 means about 4 pCi/L of radon; the maximum allowable amount in the U.S. (This number of ions is directly proportional to radon concentration multiplied by average ion lifetime: strong electric fields indoors will reduce the ion lifetime.)

Because it is unlikely that a level so high (1000, or 1.00 on the counter) can come from anything else (other than flame, smoke, or a hot electric heating element), it is likely that 1000 ions/cm3 in a basement means about 4 pCi/L of radon are present (or 2000 ions/cm3 = 8 pCi/L, etc.). Note that if radon is the source of the ions, then the concentration of ions will be approximately equal throughout the basement. If it is instead 1000 near a hot water heater but only 100 ions/cm3 elsewhere, it is not radon. A higher concentration of + ions near cracks in the concrete foundation or near corners indicate the radon is coming in there.

If the average "+" ion count is low (for example, less than 100), then there is essentially no radon present. It is not possible to "hide" the ions that radon produces. "No ions" means "no radon". Occasionally, a small piece of dust will discharge on the plate. Dust is usually "-", so the plate will read typically -1000 (-1.00) or so, even if the POLARITY switch is on "+". This will return to normal in about 3 seconds. Holding the counter near any alpha particle source (Uranium, Thorium, etc.) will produce very high ion readings, especially "+". This Ion Counter can therefore directly be used in place of a Geiger Counter. Turn the switch to STANDBY and polarity to "+". Remove the wind guard and hold the top of the Ion Counter close to the test source of possible radioactivity. If .1 microCurie of 5 to 8 MeV alpha (Uranium, Thorium, Radium) is entering the top hole, the display will read 250,000 ions/cm3 ("250" on the 1999 scale). These alpha particles can only travel through about 5 cm (2") of air, so hold the top of the counter very near the suspected source. The display is proportional to the radioactivity present. Neutrons can also be detected by putting a thin layer of plastic (a hydrogen source) over the rectangular slot. This will convert hi-energy neutrons to protons, which can be detected because protons create ion pairs. Sensitivity is a few orders of magnitude less than sensitivity to alpha particles (as described above).

Instructions for usage

1. Start with the upper right switch on STANDBY and the knob at OFF. Then turn the knob to 19.99. This will start a 50 second warm-up. During this warm-up, all 3 decimal points will be black. After warm-up, only one decimal point will remain. Then push the right switch down to RE-ZERO and hold there at least 5 seconds. The display should now read between 0.02 (positive) and -0.02 (negative) and it should be stable. That is, it should stay in that range at least 5 seconds. If the display is not stable, RE-ZERO again. Then check that the wind is not blowing. If air is being forced through the Ion Counter, shield the front with your hand and the back with your body and wait until the display becomes stable. Then RE-ZERO again. Alternatively, in windy conditions, you can balance the left switch (POLARITY) in the center position (not + or-) and wait for the display to become stable. Then RE-ZERO. This method will produce a more accurate "zero" in turbulent conditions, but you will also have to wait longer before taking measurements, because you will need to switch away from this neutral position to either + or -, which is an additional step.

2. To take a measurement, make sure POLARITY is set either + or - (A change in the POLARITY setting will cause a short delay. See 4.), and hold the Ion Counter away from you (at arm's length) or set it down. This is because the synthetic fibers in clothing often repel ions. Turn the switch to MEASURE, which will turn on the fan and make all 3 decimal points visible for about 20 seconds. After 20 seconds, only the center decimal point will remain. The ion counter works best if connected to ground or if it is momentarily touched to a grounded object before measurement starts. To do this, touch your finger to the center screw in a wall switch plate or wall outlet while holding the counter, or touch metal plumbing or the ground itself. If the ion counter has not been grounded, then it may carry a significant static charge. This charge will either repel or attract ions, which will distort the readings. Note that all of the black surface of the ion counter (including the 4 rubber feet) is electrically conductive.

The Ion Counter

3. Now the Ion Counter is ready to take measurements and will display in units of 1000 ionslcm3, so multiply the display by 1000. For example, -0.28 = 280 negative ions/cm3. The air is sampled at the slot in the top of the Ion Counter. Hold the Ion Counter in one place at least 10 seconds on MEASURE until the reading is stable to get an accurate reading. However, to determine a trend (whether the number of ions is greater or less as you move to a new area), simply watch the display for increase or decrease as you move the counter through various areas. An ion "hot spot" or a depleted area will be apparent almost immediately, even if you don't wait 10 seconds at that spot.

4. You can switch the POLARITY switch at any time. The 3 decimal points will go black for approximately 30 seconds and the fan will turn off, then back on by itself. You do not need to RE-ZERO. Note that when the fan turns itself on, the 3 decimal points will remain for an additional 20 seconds, as in step 2.

5. Most readings can be done in the most sensitive range (19.99). If the scale indicates over range (1... or -1...), switch to 199.9 or 1999. You must RE-ZERO after you switch range (this will be obvious). To RE-ZERO, first switch to STANDBY and wait about 20 seconds for the display to become stable.

6. RE-ZERO every 5 minutes (or more often if the temperature changes rapidly). To do this, switch to STANDBY and wait about 20 seconds until the display stops changing. If a breeze is blowing, shield the Ion Counter during this 20 seconds, or switch POLARITY to neutral as in 1. above. Then once the display becomes stable (that is, it doesn't change by more than + .01 in 5 seconds) hold the switch at RE-ZERO at least 3 seconds.

7. When about 15 minutes of battery life remains, "LO BAT" indicator will come on at the left side of the liquid crystal display, most likely when the switch is on MEASURE (fan "on"). This "LO BAT" (and the colon symbol, which will also show) will fade out after about one minute, but as long as the batteries are low, it will display again every time the right switch is changed from STANDBY to MEASURE, or back. The Counter requires two 9-Volt batteries. After heavy continuous use, LO BAT may come on prematurely. Then just leave OFF a few hours so the batteries can rest. This will prolong the battery life. To replace the batteries, unscrew the back (4 screws).

Operational Notes

A. For fastest, most accurate readings, measure an entire area on a single polarity, then reverse the polarity and re-measure the entire area. (This is as opposed to measuring "+" then immediately switching to "-" at each point in a room).

B. If ion concentration is less than 100 ("0.10") a longer STANDBY settling time should be used before RE-ZERO. In this case, watch the display until it stops drifting (about 30 seconds), and then RE-ZERO. Also, the display will take longer to reach final value when on MEASURE if the ion concentration is very low.

C. If you are measuring while walking, hold the Ion Counter vertical and at arm's length. This will make the moving air perpendicular to the air flow through the Ion Counter. In windy conditions, hold it (or set it down) so it is vertical or at least perpendicular to the wind direction. If changing conditions require that it is sometimes parallel to the wind direction, have the air flow in to the top (as opposed to into the bottom, or fan side). This procedure will assure the most accurate readings. When air is rapidly flowing into the top, the Ion Counter will read slightly high, but if air is rapidly flowing into the fan side, it may read very low.

D. While walking (especially on a carpet), or if you are exposed to the output of an ionizer, you are acquiring charge. This may attract or repel ions. The black outer casing of the Ion Counter is conductive and will be at the same voltage as you are while you are holding it. It too may attract or repel ions. When walking on a carpet, best accuracy is obtained if you do not wear shoes (or if the shoes are not plastic). Shoes which do not cause you to be "shocked" when you touch a grounded object are acceptable. Alternatively, while measuring, touch a grounded object frequently (see 2.) to avoid too much buildup of charge. Also, you can set the Ion Counter (on its back or standing) on a glass tray or on a sheet of glass (plastic will not work well because it acquires a charge). Hold the glass (not the Ion Counter) while walking and touch the Ion Counter to ground just before starting measurements.

E. If the Ion Counter is at the same temperature as the surroundings, the "ZERO" will be very stable. To reach temperature equilibrium, leave the Ion Counter OFF at least 30 minutes in the environment that will be measured. If outside, minimize its exposure to direct sunlight (which will make it hotter than the

environment).

F. **MEASURE** requires about five times the battery power that **STANDBY** requires because **MEASURE** turns on the fan, so keep on **STANDBY** when not taking measurements. Also, the fan is inhibited from running during warm-up and polarity change, even when the switch is on **MEASURE**. When turning OFF, the right switch can be either in **MEASURE** or **STANDBY**.

G. To take the most accurate readings, make sure first that the display reads near zero and remains near zero in STANDBY. If blowing air or wind is moving through the ion counter while on standby, the sensor will collect ions, thus producing a non-zero signal. In that case, if you push down the switch to RE-ZERO, the new "zero" will not be accurate. This is why, in instruction 1., you should shield the ion counter when it's windy (or better yet, switch POLARITY to center position) to obtain an accurate "zero".

H. Hold the counter at arm's length away from you if you are wearing synthetic fiber clothing. This type of clothing becomes charged and upsets the ion count. Also, the outside of the case is coated with conductive paint. For most accurate readings, you should touch your hand to a grounded object before switching to MEASURE. This will "ground" the ion counter, so that it will not repel ions. (If the outer case is charged "+" or "-" it will either repel or absorb ions, so that either way, the counter will not be accurate). Also, any strongly charged object will reduce the apparent ion count if near the counter. In typical electric fields near synthetic fabric, negative ions are repelled at a speed of around 3 to 30 cm/sec (about 1-10 inches/sec). Positive ions are similarly attracted to the fabric.

I. **Do not use solvents** to clean the outside of the ion counter. It may remove the special conductive paint. Use only water.

J. The wind guard (black "handle" on top) is conductive plastic. It is also an electrostatic shield, but it can be removed to clean the metal plates inside. The plates only need cleaning if a piece of dust or lint makes a bridge between the center plate and the inside of the plate enclosure as shown.

K. Normally, when you reverse the POLARITY switch while on STANDBY, the display should settle back down to near "zero' after 30 seconds. If a dust bridge is present however, the display will not settle near zero within 30 seconds after you reverse the polarity switch. Instead, it will settle on +/- .10 or higher. For example, if the display reads, "-0.01" on STANDBY, with the polarity switch at "-", but after switching to "+" (and then waiting 30 seconds on STANDBY), it reads "0.15", this means that a piece of lint or other material (at least 5 mm long) is forming a conductive path or bridge. To clean, snap out the wind guard and blow air into the slot, or clear the space inside with a strip of paper at least 10 cm (4") long to dislodge any material that is forming a bridge in the gap. The counter will also work without the wind guard in place, but the reading will be too high if wind is blowing toward the top, and too low if wind is blowing in the opposite direction. Also, without the wind guard (which is also a conductive electrostatic shield), the counter could read too high or too low while being moved toward or away from a highly charged object. However, even if the wind guard is not in place, the counter will read correctly after being held motionless about 20 seconds, even if near a charged object.

L. When switching to MEASURE, the display may go slightly negative, even when POLARITY is on or vice-versa. Then it will recover. Within 20 seconds, this transient will settle and the counter will read the correct ion count, and will continue to be correct even as you move the counter through the area you're testing. However, if you see a sudden increase or decrease in the ion count, hold the counter still for at least 10 seconds for a correct new reading. This will allow you to find areas with high (or unusually low) ion concentration. Ion concentration may change significantly depending on the time of the day and position (such as height above the floor) inside a room.

M. The counter has an ion polarity selectivity of approximately 20. This means, for example, that if there is a very high positive ion concentration, the display may read positive even when switched to negative. With this selectivity, 1000 positive ions and no negative ions per cm3 will lead to a reading of "1000" when POLARITY is on "+", and positive 50 (not negative) if set on "-". If the display shows that one polarity of ions is more than five times as numerous as the other, a more accurate reading will result if you subtract 1/20 of the high number from the low. In the case above, 50 minus 1/20 of 1000 = "zero" negative ions.

N. When the LO BAT display shows (when the batteries become weak, it will first appear when on MEASURE), it means you have approximately 15 minutes of MEASURE time left before the batteries fail. (When they fail, the readings become unstable). Replace with 2 standard 9 Volt batteries (alkalines will have about 3 times the life of regular batteries).

O. Ions are produced by high-energy events, such as an open flame or a very hot object (hot enough to glow). Hot objects usually emit equal numbers of "+" and "-'~ ions. In addition, high DC voltage (over 1000 Volts), especially when connected to pointed metal edges or needles, will produce ions of the same polarity as the voltage source. This is the basis of home ionizers. Evaporating water will produce "-" ions in the air and as a consequence leave "+" charges behind in the water that hasn't yet evaporated. If the excess "+" charges left behind are not conducted back to ground, the water will become "+" enough that "-" ion production will cease.

P. You can set the polarity on "neutral" (neither "+" nor "-") by balancing the POLARITY center position. Then the sign (+ or -) of the display and its magnitude will tell you which type of ion predominates in the air and its approximate concentration (although the actual reading will only be about 1/10 the true sum of the +/- ion concentrations). When switching back to "+" or "-" afterward, allow about 30 seconds for the display to settle.

Q. It is possible that a small piece of lint or string can interfere with the motion of the fan. Always check that the fan comes on when it is supposed to, and if not, push it with your finger, or blow on it to start. The fan is very low-force and cannot hurt your finger. Check for and remove any material that may interfere with the fan motion. The fan should operate whenever the counter is on and the right switch is on MEASURE. The only two exceptions are that the fan will not operate during the first 50 seconds after the unit is turned on, or during the first 30 seconds after the POLARITY switch is used.

Instrument Specifications

The Air Ion Counter pulls air (or any other gas with ions present) through a parallel plate assembly. Outer two plates are held at polarization potential ("+" or "-"). Center is the linear detector plate. Air gap is 4mm and polarization field is 1000 V/m.

Air flow: 200 cm3/sec (linear speed: 40 cm/sec)

Ion collection efficiency: 65%

Input resistance: 5 X 1010 Ohms

Dynamic range: 10 ions/cm3 (corresponds to 10 microVolts at detector plate) to 2 million ions/cm3 (corresponds to 2 Volts at detector plate)

Settling time: approximately 10 seconds

Noise level: (10 seconds averaged): 10 ions/cm3

Accuracy: +/- 25% for fast ions (mobility greater than 8 x 15-5 m/s per V/m - these are the most numerous ions. The Ion Counter is less sensitive to "slow" ions such as charged pieces of dust).

Batteries: 2x 9V standard transistor radio or alkaline type.

Battery life: 10 hours on STANDBY, or 2 hours on MEASURE. Alkaline is 30 hours on STANDBY, or 6 hours on MEASURE. LO BAT indicator comes on at 7.5 Volts (for each battery, or total 15 Volts). Indicates 10 to 30 minutes of MEASURE time remain.

Battery drain: 7 mA on STANDBY, 30 mA on MEASURE. Fails at 7 V/battery. Ion Selectivity (crosstalk): 20x Sensitivity with POLARITY switch in center position (neither "+" or "-") : 1/10 of normal, but adds together "+" and "-"ions. (Example: 600 "+" and 200 "-" will read 1/10 of 600 minus 200, or 40 ions/cm3).

Sources: http://en.wikipedia.org/, www.trifield.com/, www.satotech.com/, sprg.ssl.berkeley.edu/

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