ANOMALOUS SURFACE AND TRANSPORT PHENOMENA ON SOLID-FLUID INTERFACES; ARE THEY MACROSCOPIC QUANTUM EFFECTS?

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OUTLINE

Definition of an anomaly and what we call our anomaly, and what others call it

Basics on adhesion and filtration

A list and description of anomalies

Detailed description of several of our and others' experiments and discussion of results

The quantum explanation

What it is not

Conclusions, future plans and prospects

Anomaly in science is an observed fact that is difficult to explain in terms of existing conceptual framework… Some anomalies are recognized as such only after they are given compelling explanations… Before this recognition, the peculiar facts are taken as givens or are ignored…

A. Lightman and O.Gingerich, "When do anomalies begin?", Science 255, 690 (1991)

We call our anomaly:

"VERY FAST" (INSTANTANEOUS?) TRANSPORT OF PARTICLES OVER LARGE DISTANCES, PENETRATING THROUGH SOIL, ROCK AND HIGH EFFICIENCY FILTERS

Most other people call it:

UNKNOWN CHEMISTRY AND PHYSICS OF NON-GASEOUS ELEMENTS, WHICH READILY DISSOLVE IN GAS PHASE; MOST LIKELY THE ATOMS ARE BEING WRAPPED AROUND BY H_2O MOLECULES MAKING THEM BEHAVE LIKE A WATER VAPOR

Basic facts on magnitude of adhesive forces

These forces are very **short-ranged**. At about **0.1 nm distance there is a sudden** and relatively **deep dip** to negative (attractive) values.
The energy of the bond is about **0.1 eV**

Outside 0.1 nm the forces are **negligible**

Smooth adhesion is proportional linearly to diameter of a particle

Rough adhesion (taking into account the role of asperities) applies to particles greater than 1 μm, making it weaker; smaller particles, though, that fall into 'nooks and crannies', are bound more strongly. When squeezed out by stresses, they can be subject to our mechanism (will be explained later)

The ratio of inertial (gravitational) to adhesion forces is proportional to the cube of the diameter of a particle

As a result the **small particles** (below 0.3 μm) **cannot be removed** by mechanical forces (shaking) once they get stuck to surfaces

Ref.: K. Kendall, Science 263, 1720 (1994)

Basic facts on filtration of aerosols using high efficiency porous membrane filters

MICRO

MACRO

10 nm particle

1 m car

10000 nm length of a **pore**
(note: both are **tortuous**)

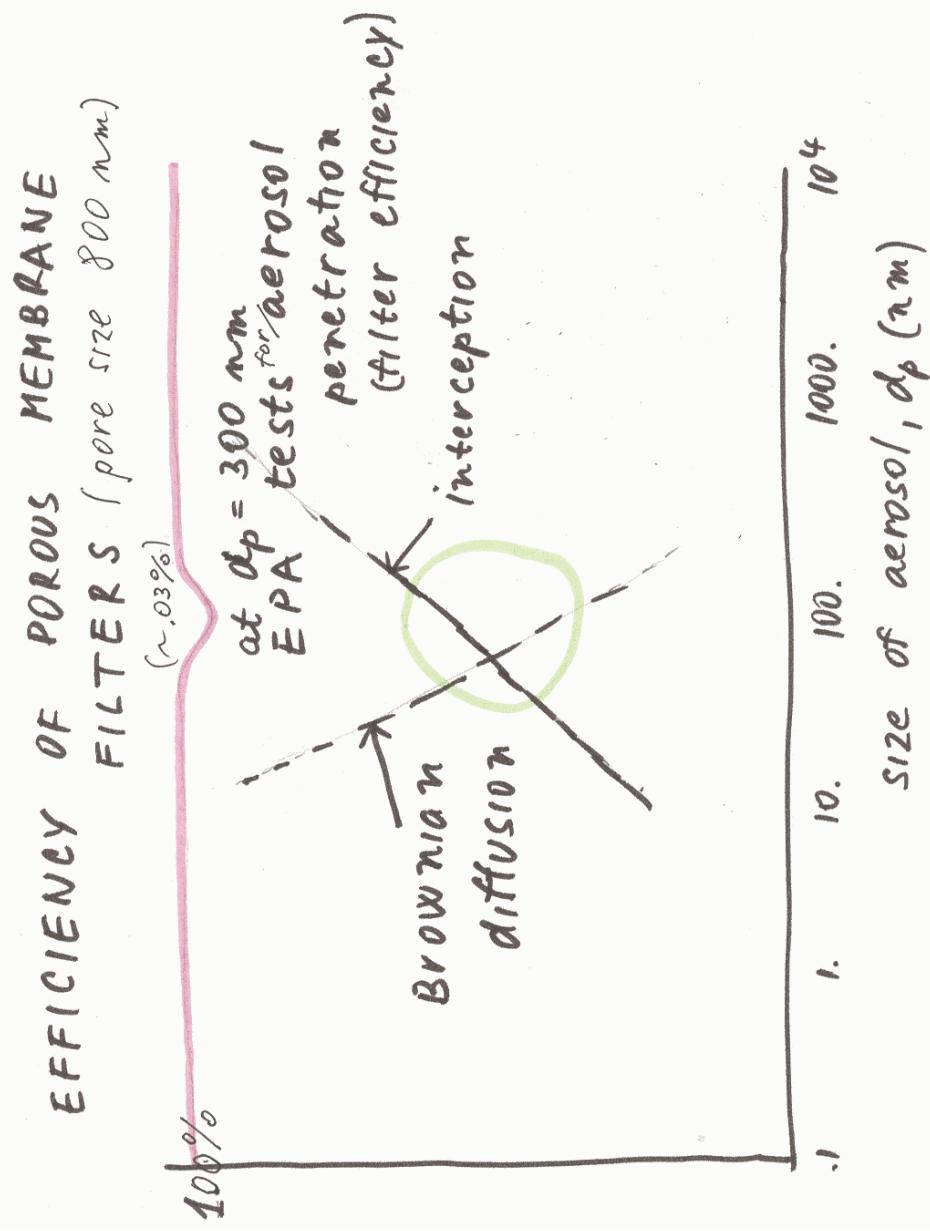10 km long **tunnel**

100 nm mean free path

10 m mean free path

800 nm diameter of a pore

80 m diameter of the tunnel

The velocity of both particle and the car is about 100 km/hour. The chance of hitting the walls is 100%

WHY POROUS MEMBRANE FILTERS ARE ALMOST 100% EFFICIENT

EFFICIENCY OF POROUS MEMBRANE FILTERS (pore size 800 nm)

(~.03%)

100%

at d_p = 300 nm
EPA tests for aerosol penetration (filter efficiency)

interception

Brownian diffusion

size of aerosol, d_p (nm)

1.   10.   100.   1000. 10^4

A (LONG) LIST OF "UNEXPECTED" RESULTS (ANOMALIES)

- 1. Ultrafine aerosols ("geoaerosols") originating inside in isolated mines and caves (our experiments, 1985, 1994,1998,1999,2002). Many others saw aerosols in isolated caves but always assumed they were from the outside

- 2. Prospecting method to discover hidden deposits (geoaerosols penetrate through rock, soil and filters); discovered by Krcmar 1980-2004, used by the Chinese group, 1992-present, Mann A.W., "mobile metal ions", 1995-2000, Australian Geophysical Survey (CSIRO), project "Glass Earth", 2003-2004

- 3. Our systematic investigations in laboratories, indoor and outdoor (not in mines...., mostly with R.F.Droullard, not all published), 1996-present

Contd...

- 4. "Orphan" daughters – airborne short-lived radioactive aerosols not supported by their parents (our work, S. Schery, G.Wallner, J.Lebecka, Abu-Jarad, Hovorka, P.Cauwels; 1997-2005)

- 5. The variability and the unexpectedly high values of Rn, Tn and An emanation coefficients from solids (Austin & Droullard, Howard et al., Balek et al.; 1970-present)

- 6. Surface diffusion ("hopping", "slip lengths", "jump lengths"). Gomer's review article says it's "not understood and difficult to measure" (1990, cited about 615 times on the Web of Science). The length of "jumps" seems unquantifiable. If the jumps are quantum, it means the jumping entities can take all paths (Feynman interpretation of QM) – not just on the "surface" …; implications of that are profound

Contd…

- 7. Enhanced flow in carbon nanotubes (5 to 20 nm long), which could mimic the selective transport and extraordinarily fast flow in cell channels, is 10e5 faster than predicted from fluid-flow theory.

- 8. Fingering and hysteresis in fluid transport. Saying "it's fractal" is not explaining the fact that matter moves much faster in the best possible uniform environment. Is it "surface" diffusion? It cannot be a high kinetic energy (inertial) effect (K.E.>>P.E.) because the bulk movement of the fluids is very slow (cms/day)

- 9. "Mass losses" of plated-out aerosols (particles sitting on surfaces are also called adparticles). Hopke et al., 1983

- 10. Polonium halos, perfectly centered alpha particle formed discolorations coming from at least 10e8 cluster of decaying Po atoms; no explanation for their formation, embedded in Ps old rocks, exists (Gentry et al., 1970-present); a huge controversy still surrounds this issue

Contd…

- 11. Solubility of apparently all elements in water vapor and some other gases. This is the explanation for our anomaly most people agree with. Williams-Jones et al., Marsik et al., Symonds, Morey et al., 1920-present. However, it is known that gases are poor solvents….

- 12. Nucleation theories (homogeneous, heterogeneous, binary, bubble formations,…) differing often orders of magnitude from the data. Zdimal et al., 2003, Marsik et al., 2005. Also it appears unquantifiable….

- 13. Plutonium "internal sputtering", observed at room temperature and pressure. Sputtering, however, is always done in 10e-9 Pa vacuum (Cheng et al., 2005). If not, a molecule thermalizes in a few ns and diffuses back to surface

Contd…

- 14. Surface driven coagulation of freshly formed Rn daughters (Po218) on 1 to 10 u monodispersed aerosols (Kruger et al., Hopke et al., 1975-1980). The anomaly here is that at these sizes the coagulation is proportional to square of the particle diameter rather than the expected linear proportionality. It is closely related to the plateout phenomena (Holub, Benes, 1984-present)

- 15. Signaling (communication) in living matter, where the accuracy is better than 1 ppm (Philips and Quake, 2006). Diffusion and reaction-diffusion cannot explain the speed and such accuracy. Is there a need for a macroscopic quantum effects using a notion of "quantum receptors"? Does quantum mechanics play a non-trivial role in life? (Davies, 2004, 2005)

Twilight Mine in SW Colorado where the ultrafine aerosols deep in an isolated part of the mine were discovered in 1987-1994
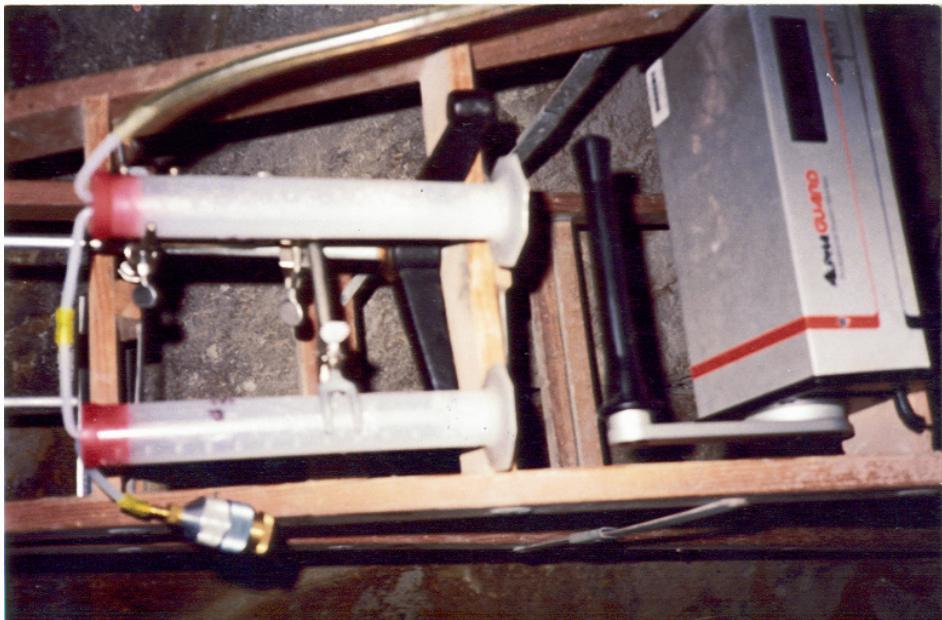
PREPARATIONS FOR THE MINE EXPERIMENT.

MEASUREMENT IN A VENTILATED PART OF THE MINE; BUBBLERS ARE IN SERIES

The liquid in the bubbler always contained Ra226, Pb210 and Po210, not in equilibrium
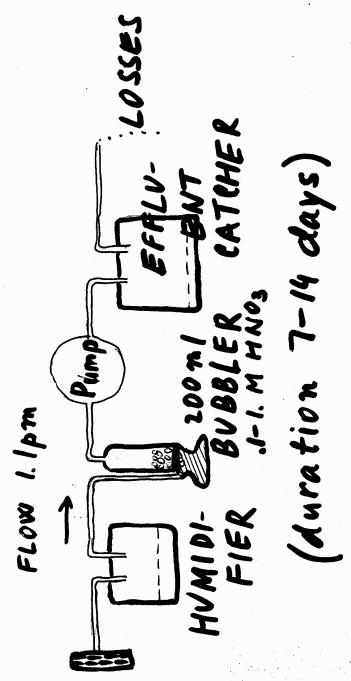
Long-lived U238 was always below detection limit (BDL)

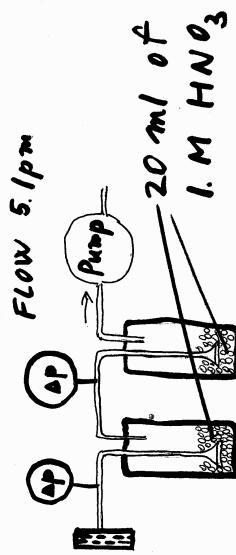# MEASUREMENT DEEP IN AN ISOLATED PART OF THE MINE, BEHIND A DOUBLE BULKHEAD

1. Filter had low Ra 226 (BDL); DL=0.3 mBq

2. Ra 226 in both bubblers (unexpectedly, more in #2) had 10 to 300 mBq

This kind of experiments were reproduced at least 50 times

# Schematic of the Twilight Mine, Denver residence, and the University experiments

- In Denver residence and the lab experiments we tried to minimize losses by means of 'effluent catcher'

- Note that the bubbler #2 usually had higher concentrations than #1

- Note the difference in the lengths of runs

OPEN CIRCUITS

CSM & BEAR CREEK

HUMIDI-FIER   200ml BUBBLER .1-1.M HNO₃   EFFLU-ENT CATCHER   LOSSES

(duration 7-14 days)

TWILIGHT MINE

(duration 5-10 minutes)

20 ml of 1.M HNO₃

Twilight results; Rn concentration 450 kBq/m³

- The totals, and the shapes of nucleation events were very pronounced; higher than in caves, probably due to the mine being much bigger (1000m³) than caves

Temporal variatios in number size distributions and total number concentrations, Twilight mine, 18 -19/5/1994.
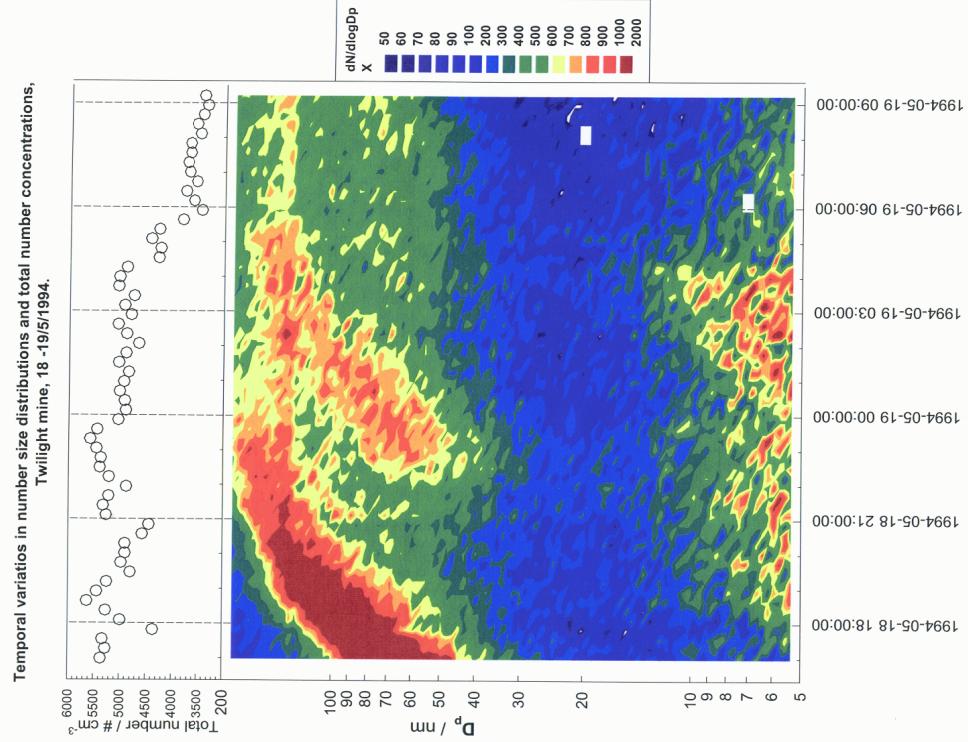
These photographs show how a geochemist takes 'geoaerosol' measurements at different heights. This instrument was used for prospecting by B. Krcmar in 1980-2004. The results were basically the same for all three

The geoaerosol phenomenon is **impervious to wind**

5 meter height

0.1 meter height

in a soil air

Krcmar's typical data set

- He has collected thousands such results, often successfully discovering hidden deposits. Yet, because the mechanism is controversial, his, and others' similar methods, have been largely ignored
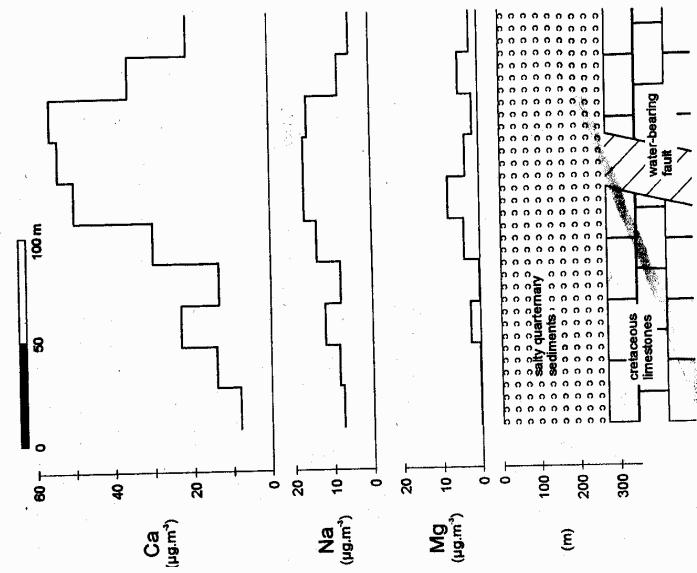

Fig. 2
Mohamadia (Algeria) 1983: concentrations of Ca, Na and Mg in atmospheric air above water-bearing fault structure

Experiments in Ponikla cave, summer 1998 and fall 1999. In 1999 NOx, SO2, were also measured; their concentration was zero (less than 3 ppb)

When the equipment was installed the cave entrance was covered and isolated from the outside

Rn levels were 1.5 kBq/m^3

NOTE THE VOLUME IS SMALLER THAN IN THE TWILIGHT MINE, RESULTING IN LOWER ULTRAFINE AEROSOL LEVELS. THE DOOR WAS SEALED BY DUCT TAPE
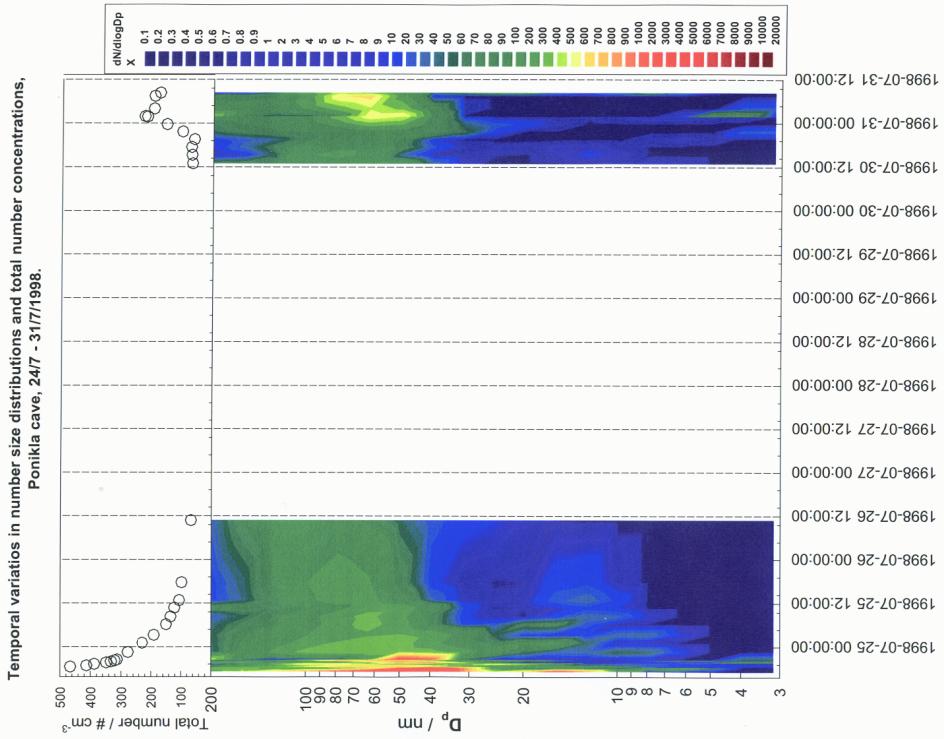
THE ENTRANCE TUNNEL SLOPING ABOUT 30 M DOWN. DURING THE SUMMER, WHEN IT WAS MUCH WARMER OUTSIDE THAN IN THE CAVE (TEMPERATURE 7.8 CELSIUS THROUGHOUT A YEAR), IT FURTHER ISOLATED THE SITE
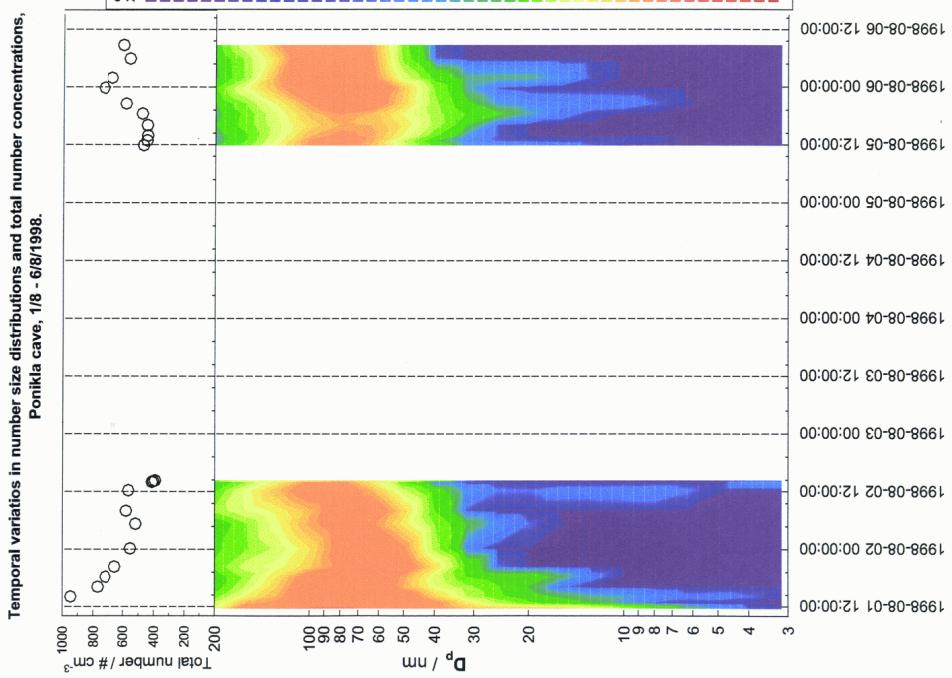
First successful run in Ponikla cave, at site 1, total volume about 20-50 m^3 (24.7 to 31.7, 98)

- Note the event on 31.8.98 evening

- During installation, the "human under stress aerosol" first observed. Its size will make it soon highly undesirable in chip making

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 24/7 - 31/7/1998.

APPEARANCE OF ULTRAFINE AEROSOLS IN THE PONIKLA CAVE AT SITE 2 (1.8 to 6.8, 1998)
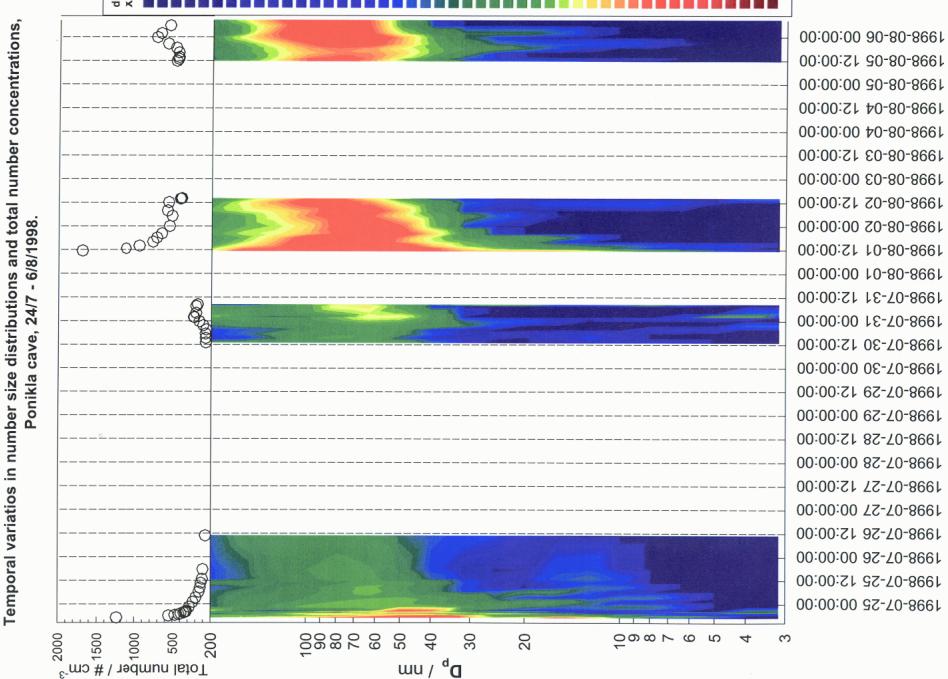
During the period of no data the cave was left alone and closed with the cover

Note the two events. Similar events were seen repeatedly

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 1/8 - 6/8/1998.
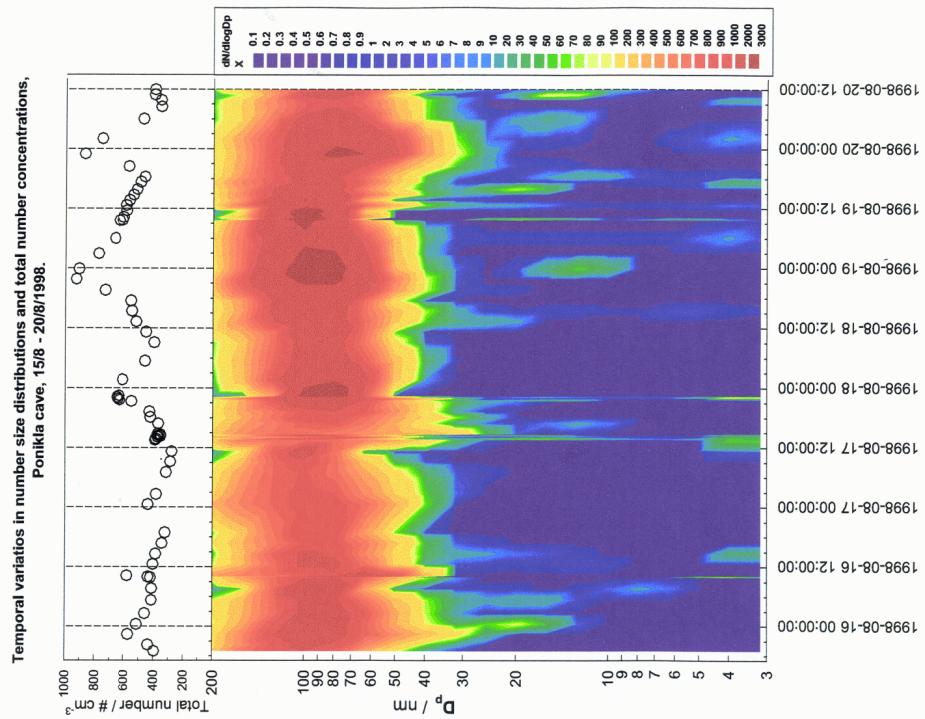
Site 1 and Site 2, in two time intervals each, showing the role of volume

- Site #2 had larger volume, resulting in several times greater totals

- Surface/volume ratios in caves are high; nucleation, plateout and recirculation are all present

Temporal variations in number size distributions and total number concentrations, Ponikla cave, 24/7 - 6/8/1998.
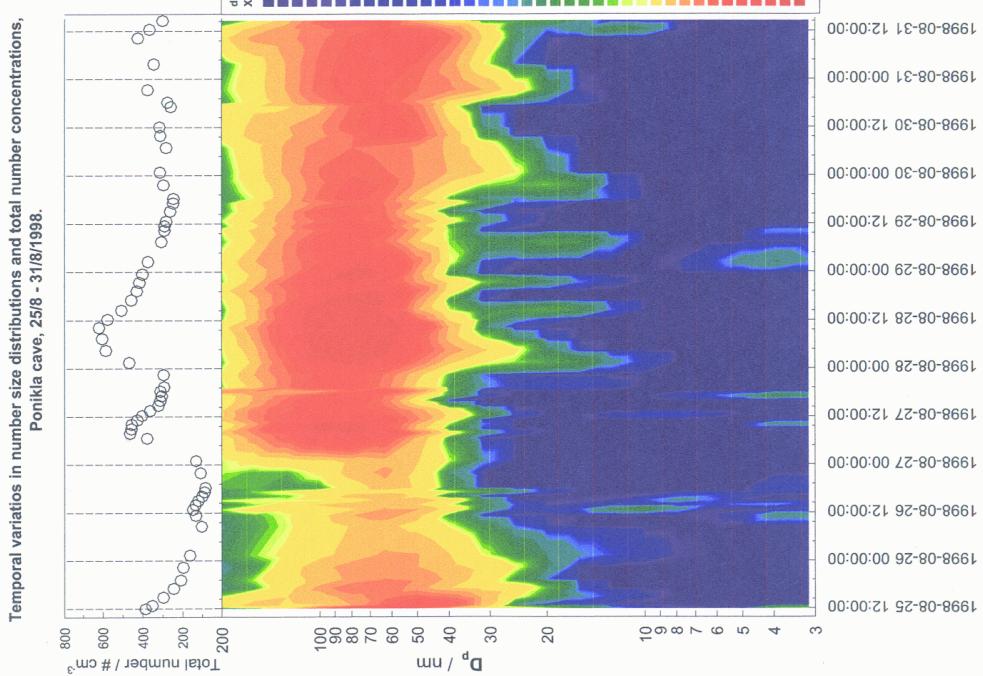
Site 3, Ponikla (15.8 to 20.8., 1998)

- Note the removal rate is quite high; if there were no sources the aerosols level would quickly reach zero

- Four distinct nucleation events can be seen

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 15/8 - 20/8/1998.
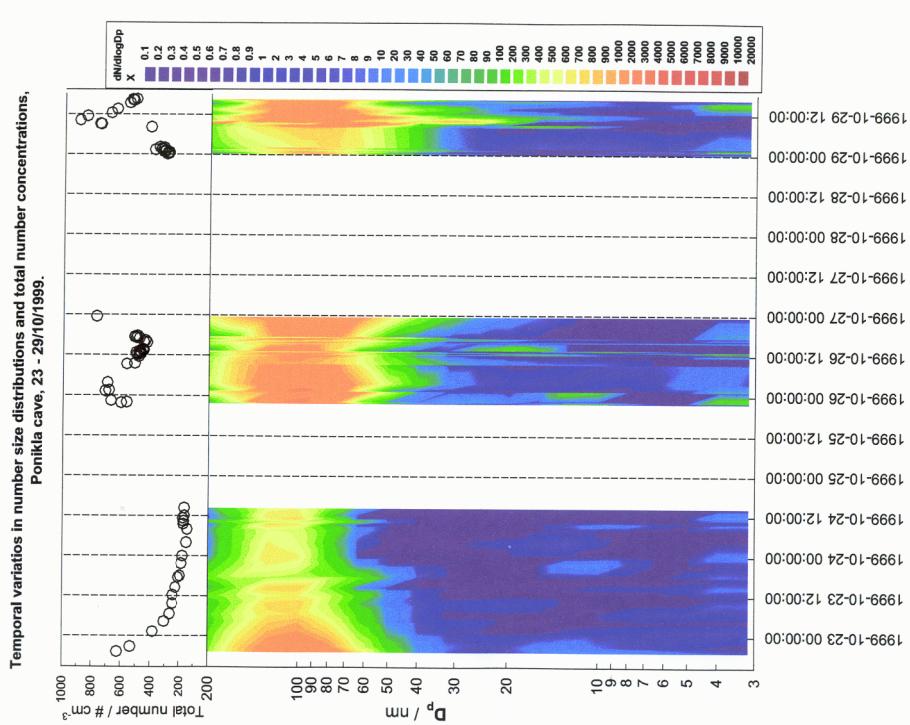
PONIKLA (25.8 to 31.8, 1998), TWO DISTINCT EVENTS RECORDED AT SITE 3, AFTER THE CAVE HAD BEEN CLOSED AND ISOLATED FOR FOUR DAYS

This was the final 1998 experiment; after that we were convinced the geoaerosols are from cave

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 25/8 – 31/8/1998.
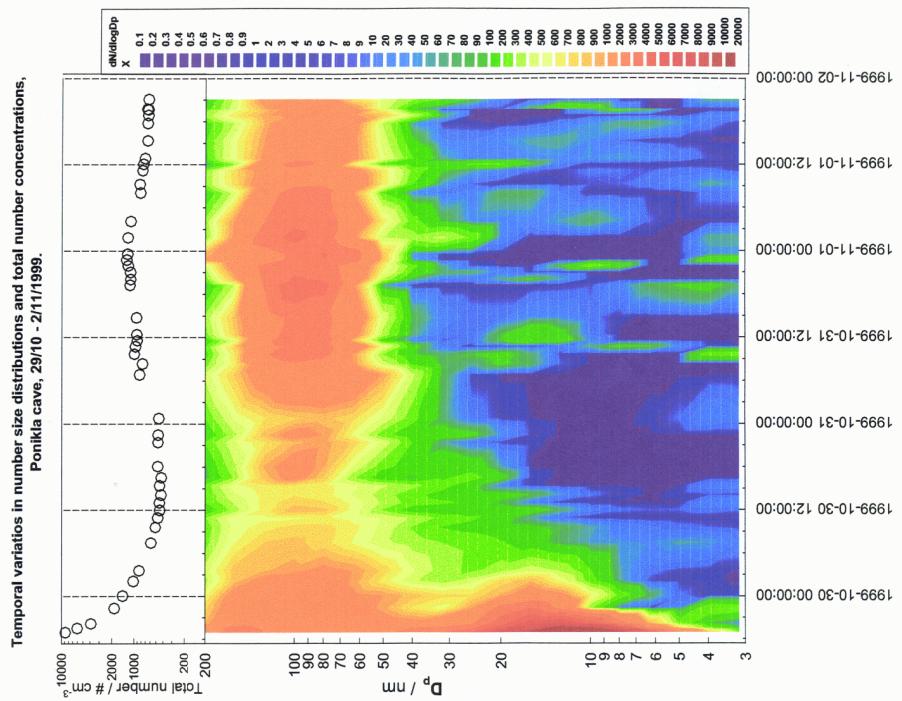
First of two 1999 experiments when airborne trace pollutants were also measured, (23 to 29-10)

- Even though outside was a high pollution day, throughout 1999 experiments the cave concentration was always zero
- Cave atmosphere is remarkably clean. The aerosols are assumed formed from gaseous pollutants

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 23 - 29/10/1999.

The final Ponikla experiment when the instruments were placed outside the walled in area

- Note the strong "human under stress aerosol" when the system was being rebuilt

- There was no difference from all the previous experiments

Temporal variatios in number size distributions and total number concentrations, Ponikla cave, 29/10 - 2/11/1999.

Zdimal Bozkov data (31.8 to 3.9. 2002)

- Note the span of sizes – from 3 nm to 10000 nm

- The presence of apparently constant source of 500-1000 nm aerosols is unexpected. Are they microbes?

Colour map of the particle number size distribution
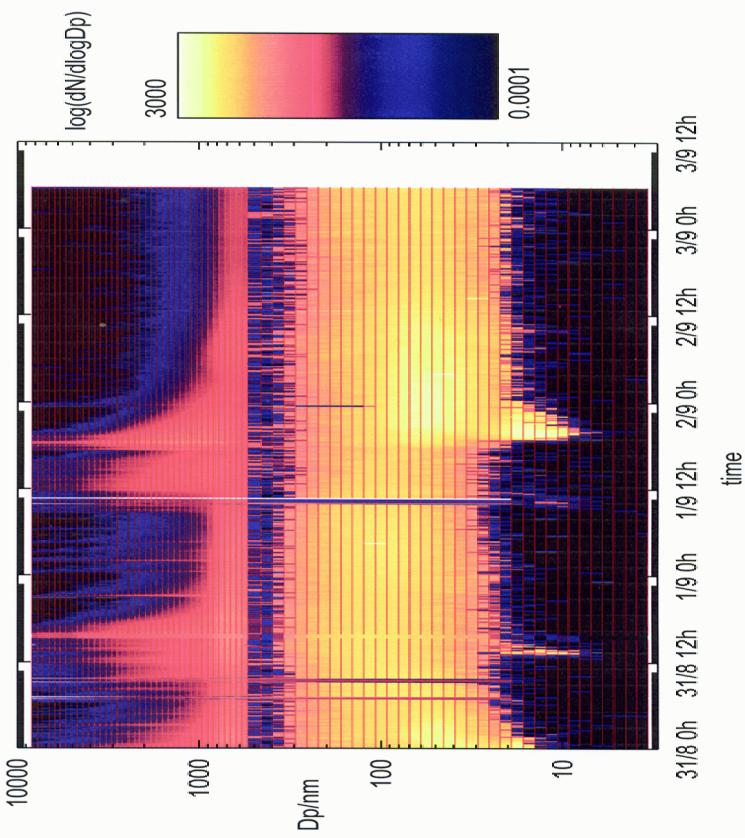
Our data from Bozkov collected using the diffusion battery

- Note the nucleation event on 3.9.2002
- "Humans under stress aerosols" present
- The results are in basic agreement with the Ponikla data

Temporal variatios in number size distributions and total number concentrations, Bozkov cave, 31/8 - 3/9/2002.
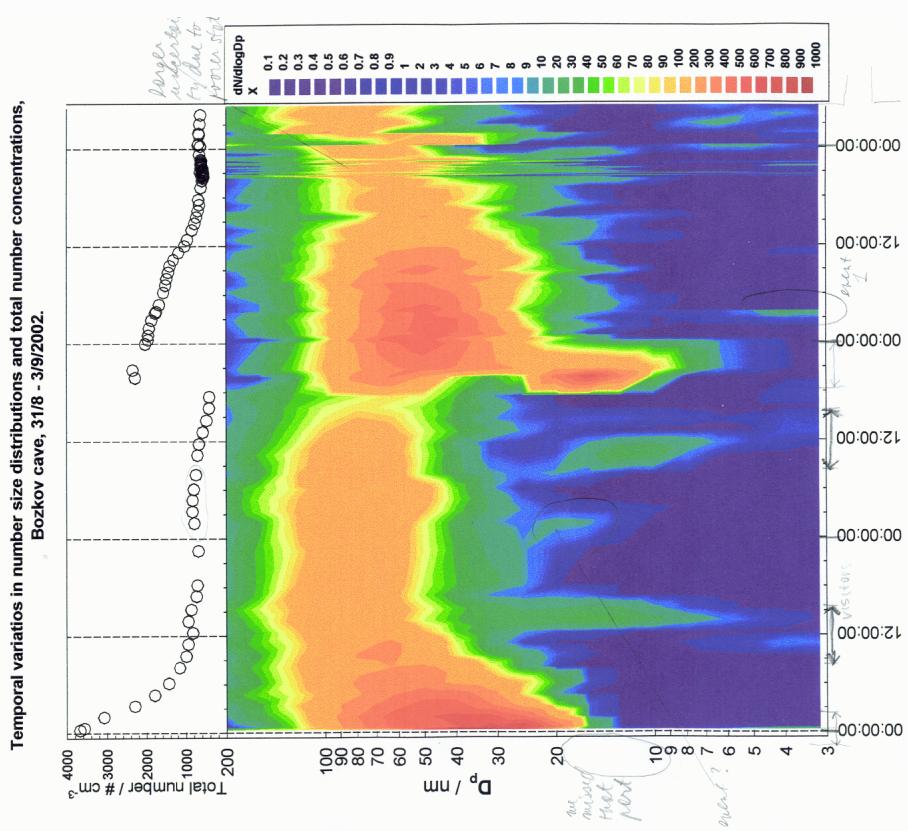
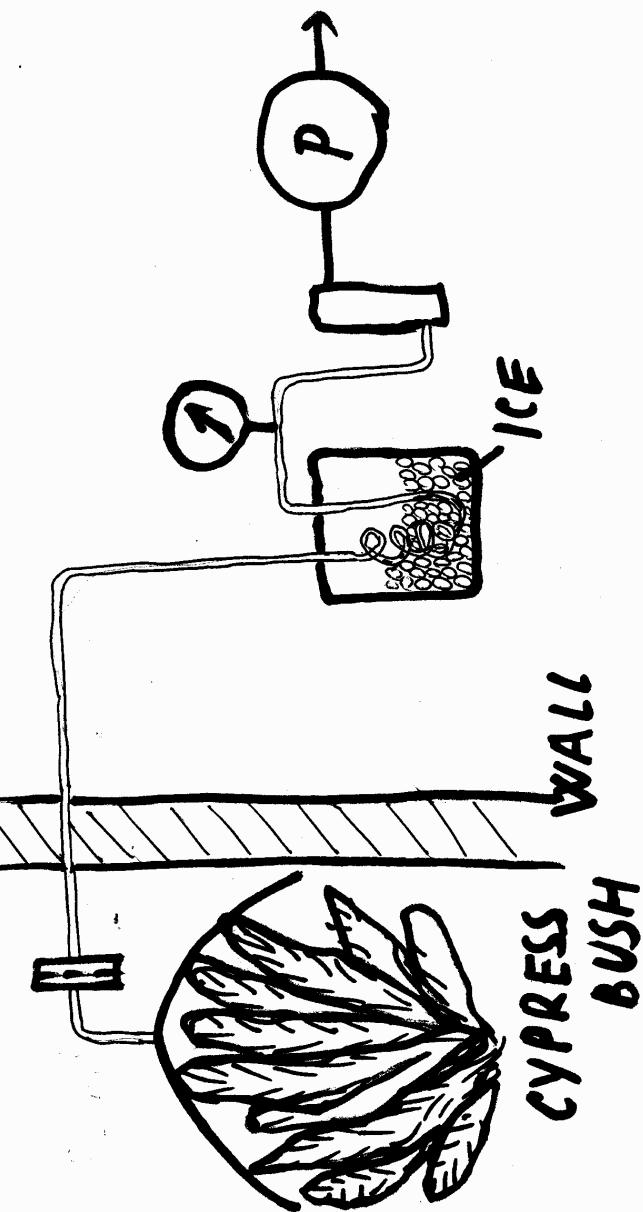# Bozkov data 3 to 200 nm, using Zdimal's plotting routine; basically identical to ours
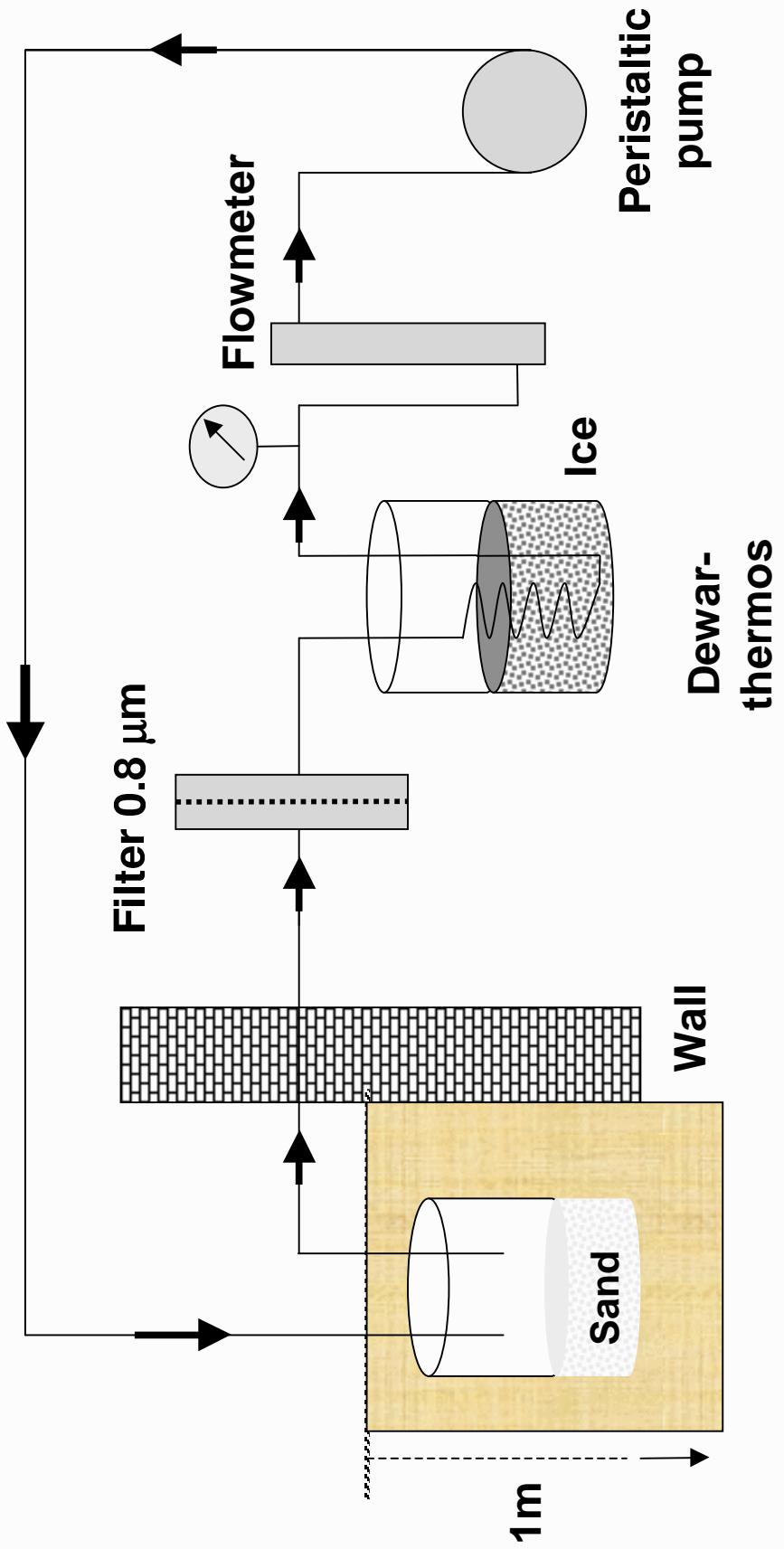

Colour map of the particle number size distribution
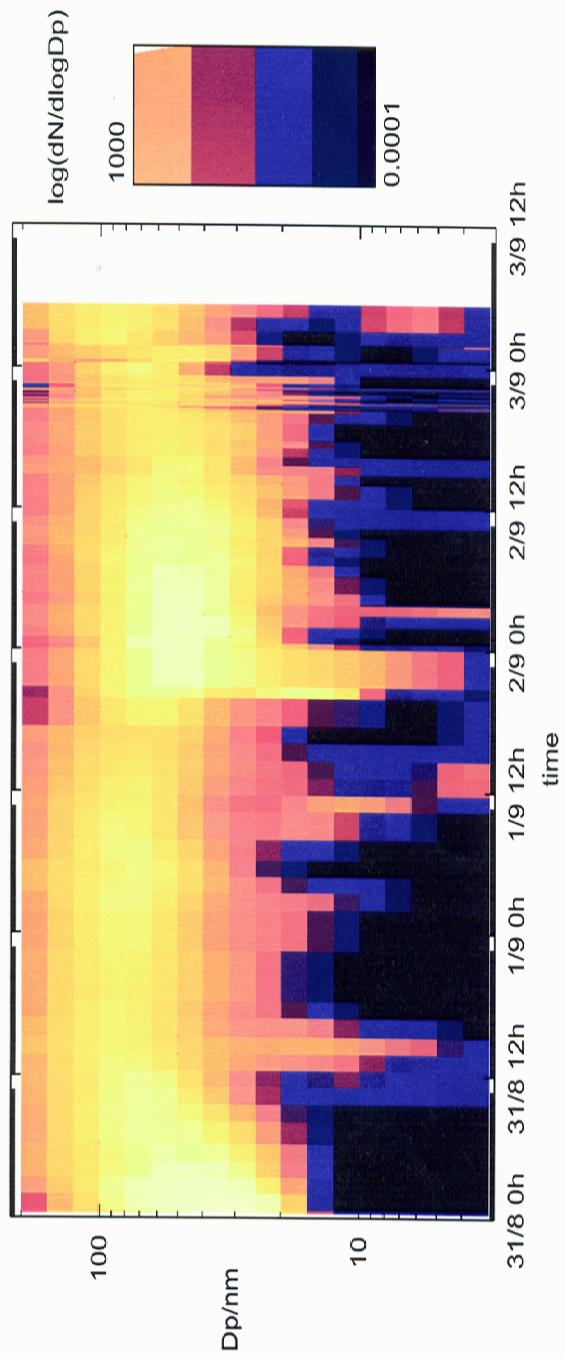
Outdoor experiment in May 2002, Denver, that showed "concentration" about 1 Bq/m³ of Ra^{226} while filter had all the long-lived activity, as expected, BDL. Similar experiments, repeated more than 30 times, gave similar results

OPEN CIRCUITS —

CONDENSERS:

OVER A BUSH, OUTDOORS

ICE

WALL

CYPRESS BUSH

Hole in Soil

Filter 0.8 μm

Flowmeter

Peristaltic pump

Dewar-thermos

Ice

Wall

Sand

1m

Closed circuit experiment. Repeated three times with similar results.

Dewar condensate contained large quantities of ^{226}Ra, ^{210}Pb and ^{210}Po. On the filter activity of those elements were below detection limit even though none of them are gaseous

U/Ra concentration in soil was about 4 ppm

U-Ore in a Jar

Filter 0.8 μm

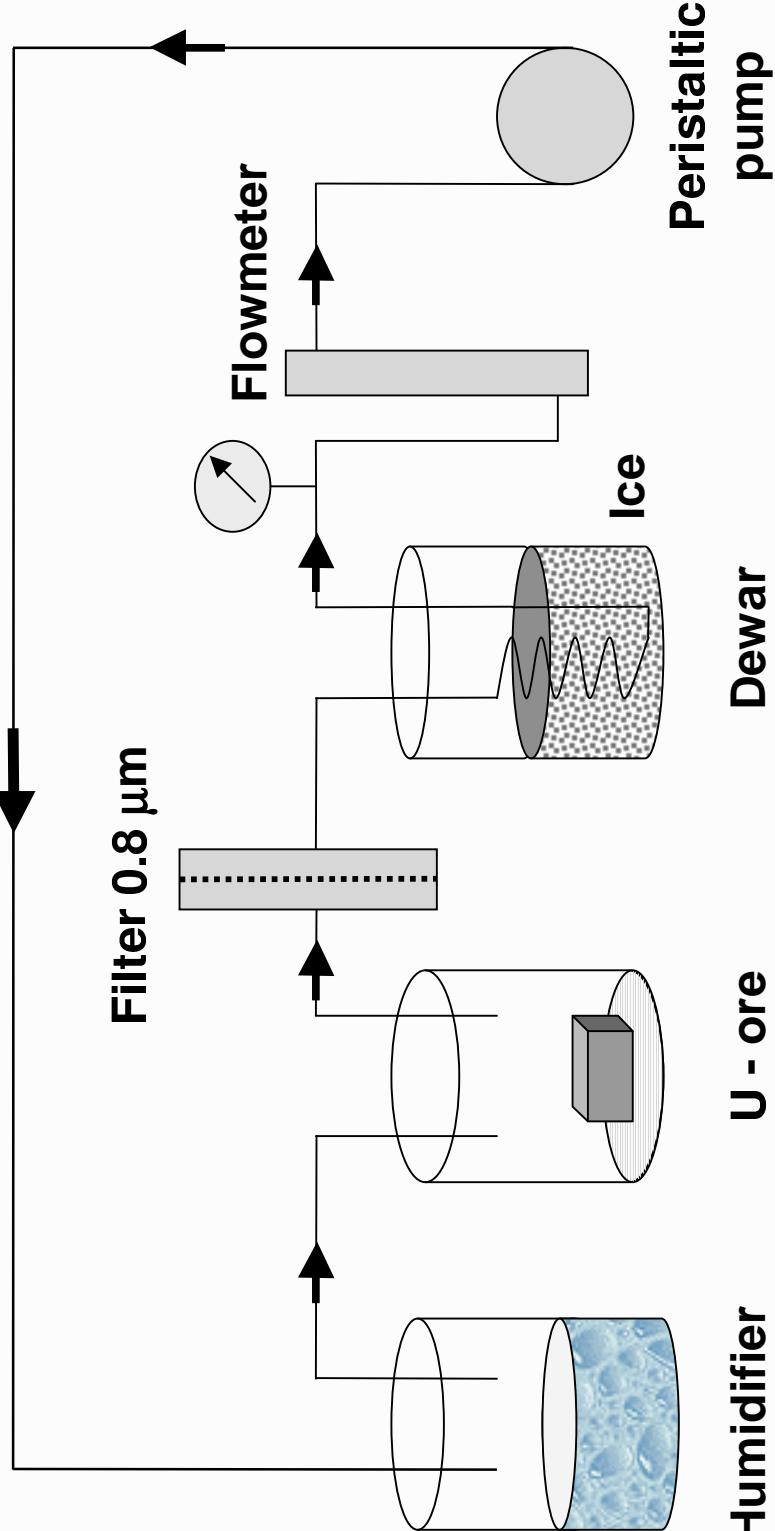Flowmeter

Ice

Dewar

U - ore

Humidifier

Peristaltic pump

Closed circuit experiment. Repeated three times with similar results.

Dewar condensate contained large quantities of ^{226}Ra, ^{210}Pb and ^{210}Po. On the filter activity of those elements were below detection limit even though none of them are gaseous

After removing the ore the anomaly persisted. Surface got covered with the particles and kept "emitting" them as the ore itself. Only after removing ore and replacing every component in the closed circuit a blank was obtained.

The problems with the "unknown chemistry and physics" hypothesis

- 1. The lack of dilution. If the "geoaerosols" were present as molecules of "unknown chemistry" in air, then, when measured in soil air, and then at 1-5 m heights, they would be diluted by a factor of 100 to 1000. Numerous Rn soil and atmospheric air measurements showed that. No such dilution geoaerosols was found in our and others' experiments, though.

- 2. The "concentrations" of metals in air, reported by Krcmar and the Chinese are in $\mu g/m^3$, while in all aerosol measurements (tens of thousands) they are always in ng/m^3.

Contd…

- 3. As shown in a previous slide, taken on a windy day, the "concentrations" are not affected by wind or height. This phenomenon is impervious to wind. If geoaerosols were present in air coming from localized sources (geological faults), then wind would disperse them quickly. This is in agreement with the point # 1 above

- 4. "Unknown chemistry and physics" hypothesis has no obvious explanation for the appearance of ultrafine aerosols (geoaerosols) in isolated mines and caves (more on that later).

- 5. Employing Clausius–Clapeyron equation, the saturated vapor pressure of most non-volatiles is 10^{-20} to 10^{-80} Pa. Air is a very poor solvent – however, air itself dissolves readily in water (Henry's Law)

The surface diffusion is not understood, even though in case of Emanation Thermal Analysis (ETA) it is easy to measure

- There are very few reliable methods of measuring surface diffusion rather than ETA; yet, there are orders of magnitude disagreements between theories and ETA data.

- Thousands of papers are trying to obtain the "jump lengths"…..

SURFACE DIFFUSION

ETA:

$$D = D_0 \, e^{-\frac{\Delta H}{kT}}$$

D - diff. coeff
ΔH - the barrier

assumed:

measured:

$D_0 = 10^6 \, cm^2/s$ $0.1 \, cm^2/s$

$\Delta H = 2.2 - 4.4 \, eV$ $0.2 \, eV$

Data from surface diffusion of Rn … typical of this field

Gomer's:

$$D_0 = \frac{1}{4} a^2 \nu_{eff}$$

a - jump length
ν_{eff} - # of attempts

How to fit any "jump" length

- Only if our macroscopic quantum jumps are invoked the data can be understood

- This form differs fundamentally from all existing attempts to explain the data

our suggestion:

$$a(x) \approx a_0 \left(a_1 e^{-x} + a_2 e^{+x} \right)$$

a_1, a_2 — coefficients determining whether the jump length is decreasing or increasing with distance

a_0 — distance between neighboring atoms

DIFFICULTIES IN TAKING QUANTUM MECHANICS SERIOUSLY; IT'S STILL GOING ON

This is well summed up in the famous letter by Planck, Nernst, Rubens, and Warburg proposing Einstein for membership in the Prussian Academy of Science in 1913, which ended:
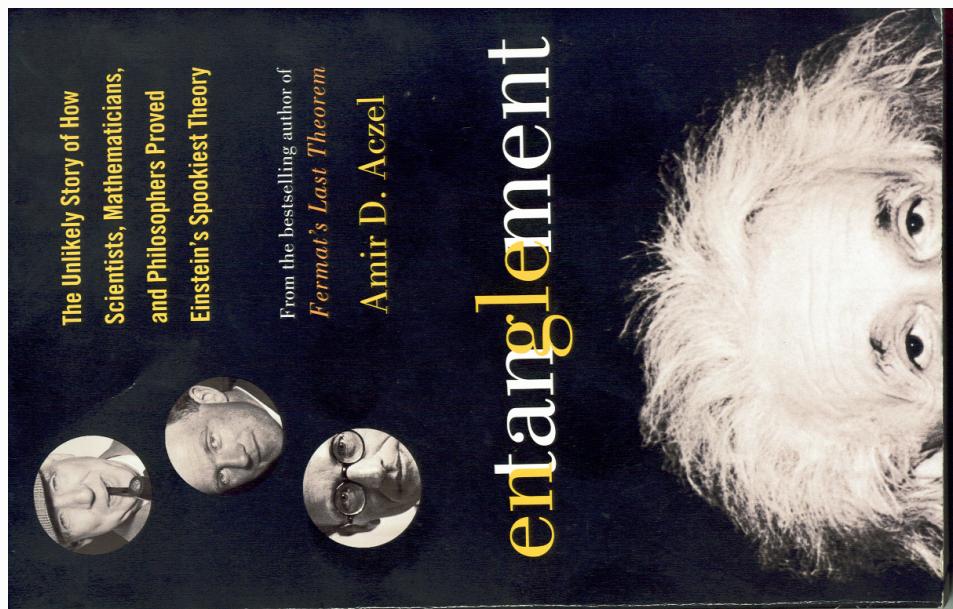
In sum, one can say that there is hardly one among the great problems in which modern physics is so rich to which Einstein has not made a remarkable contribution. That he may sometimes have missed the target in his speculations, as, for example, in his hypothesis of light-quanta, cannot be held too much against him, for it is not possible to introduce really new ideas even in the most exact sciences without sometimes taking a risk.

This was written the year in which Niels Bohr published his paper on the quantum theory of the hydrogen atom!
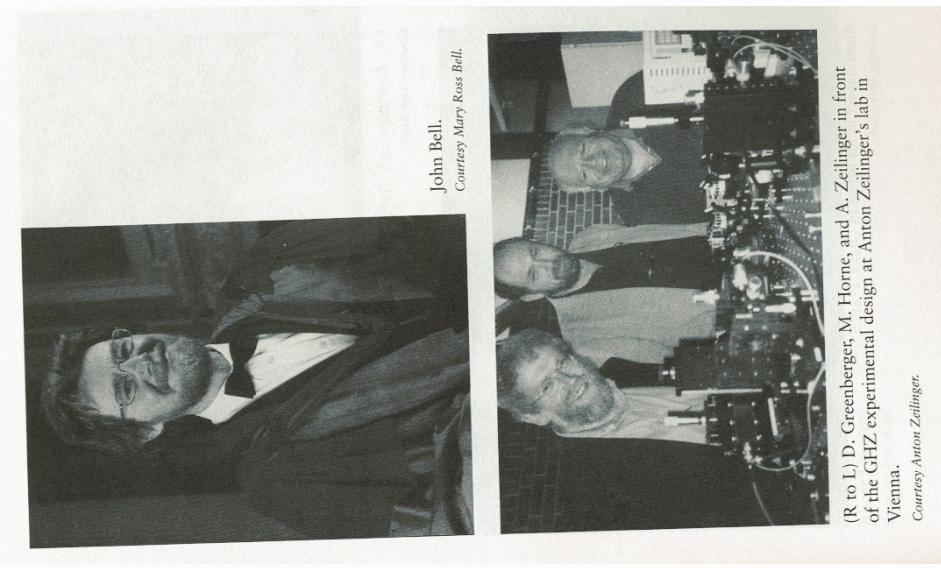
ONE OF THE KEY POINTS IS THAT QUANTUM EFFECTS CAN BE MACROSCOPIC (NONLOCAL)

- Einstein considered "spooky action at distance" as nonsense

- Bohr "solved" it; Schroedinger was worried; Heisenberg was equivocal

The Unlikely Story of How Scientists, Mathematicians, and Philosophers Proved Einstein's Spookiest Theory

From the bestselling author of *Fermat's Last Theorem*

Amir D. Aczel

entanglement

THE MAIN CREATORS OF THE SECOND QUANTUM REVOLUTION

John S. Bell's inequality proved it can be decided if nonlocality exists

Zeilinger, Horne and Greenberger showed it's "equality"

Experimentalists then proved it (repeatedly)

John Bell.
Courtesy Mary Ross Bell.

(R to L) D. Greenberger, M. Horne, and A. Zeilinger in front of the GHZ experimental design at Anton Zeilinger's lab in Vienna.
Courtesy Anton Zeilinger.

Over the past few decades, scientists have learned that simple rules can give rise to very rich behavior. A good example is chess. Imagine you are an experienced chess player introduced to someone claiming to know the game. You play a few times and realize that although he knows the rules of chess, he has no idea how to play well. He makes absurd moves, sacrificing his queen for a pawn... He does not truly understand chess; he is ignorant of high level principles...

These principles are collective or emergent properties of chess, features not immediately evident from the rules but arising from interactions among the pieces on the chessboard.

Scientists' current understanding of QM is like that of a slow learning student of chess...
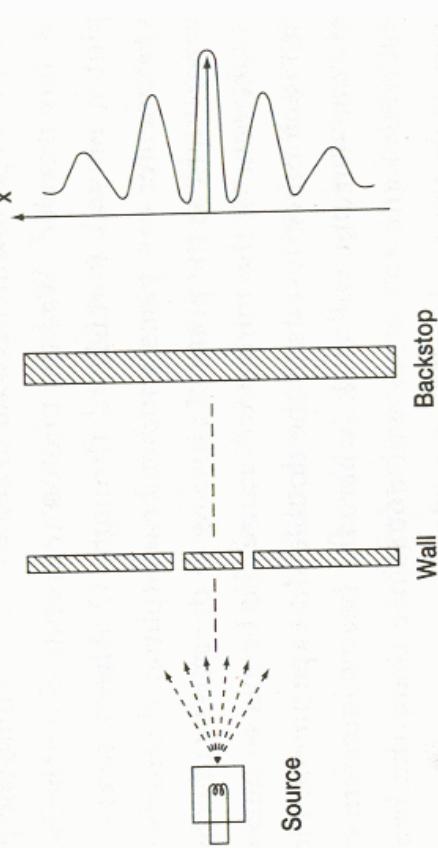
M.A.Nielsen, "Rules for a Complex Quantum World", Scientific American. Abril 2003. p. 67

CLASSICAL DOUBLE SLIT EXPERIMENT

Take a vote – does the particle go through one slit and knows it's not measured

Or does it go through both slits simultaneously?
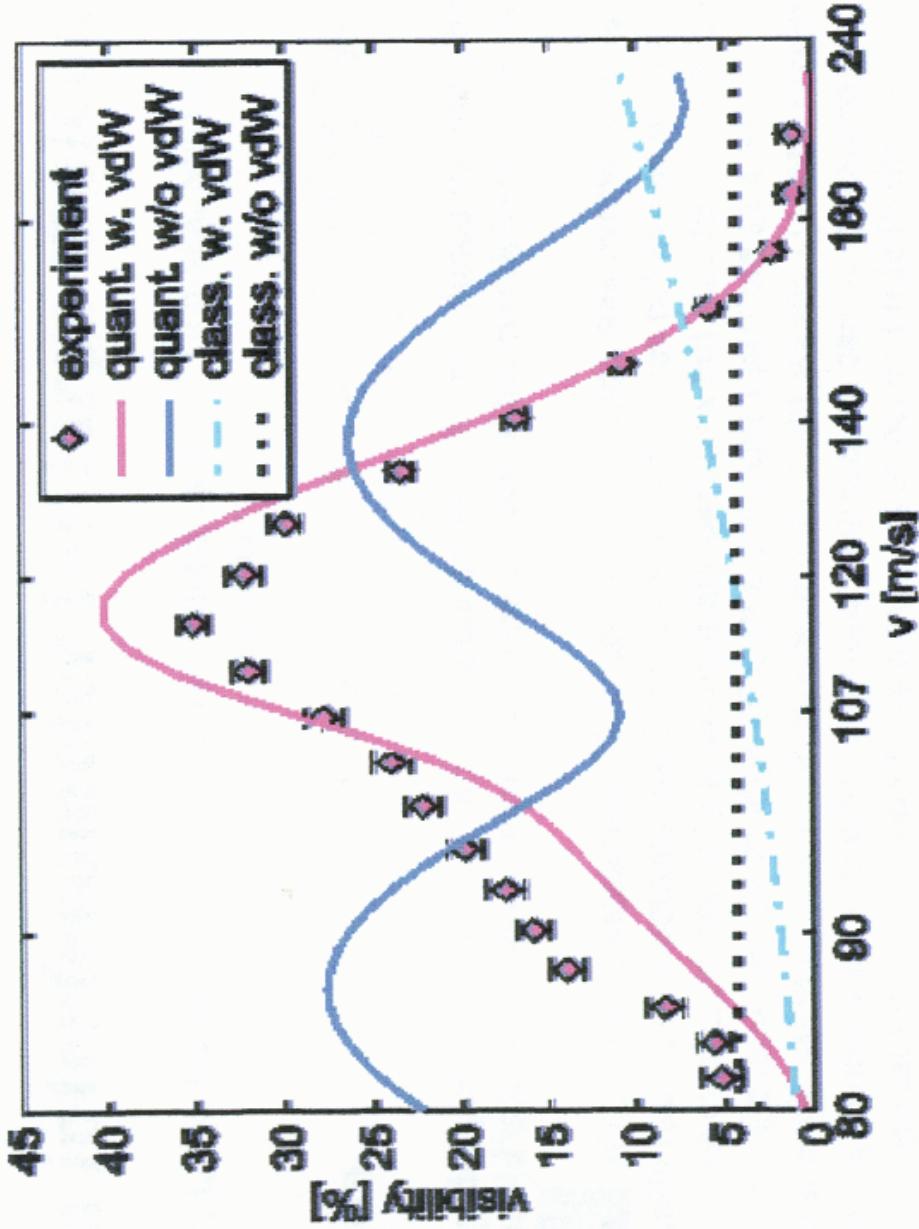
Recall Feynman's interpretation of QM: it goes via all paths

Source

Wall

Backstop

x

MANY SLIT INTERFEROMETER AND THE PROBLEM OF DECOHERENCE OF FREE PARTICLES (Talbot-Rau interferometer used to measure $C_{70}F_{48}$ molecules)
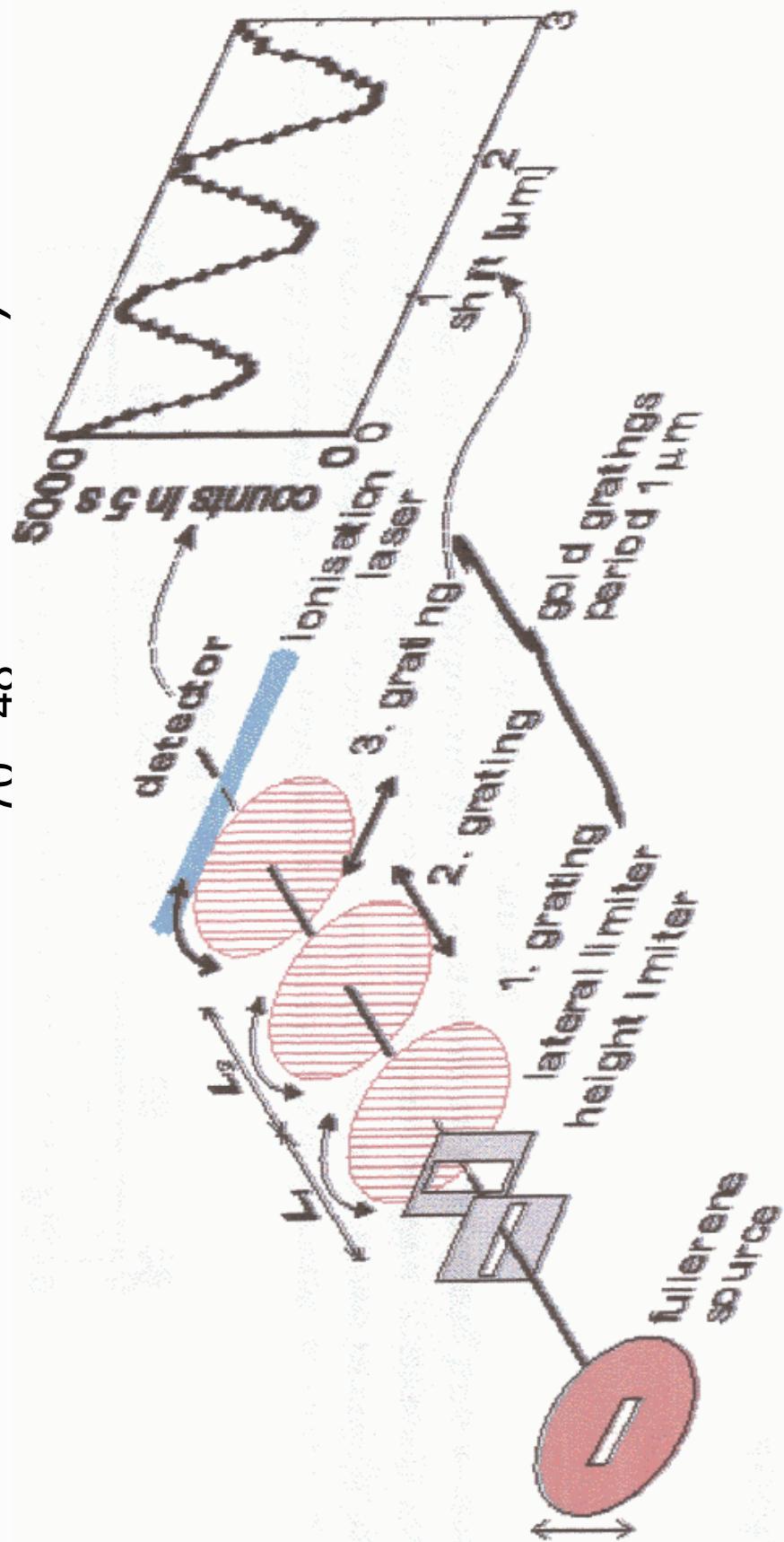
TYPICAL RESULTS. THE deBROGLIE
WAVELENGTH IS IN pm. NOTE THE STRAIGHT
LINES FOR CLASSICAL "INTERFERENCE" (w.
vdW = with van der Waals forces…)

NOTE THE (PLANNED) SIZE RANGE OF THE PARTICLES UNDERGOING INTERFERENCE. THE RANGE (1-30 nm) COINCIDES WITH THE RANGE IN THE PHYS. TODAY SLIDE.

HACKERMÜLLER et al. Decoherence in a Talbot–Lau interferometer: the influence of molecular scattering   787

object	C_{70}	insulin	GFP[a]	hemoglobin	ferritin	virus[b]
mass (amu)	840	5730	2.7×10^4	6.4×10^4	4.8×10^5	8×10^6
min/max extension (nm)	1	3	3/4	5/7	10	30
estim. σ_{eff} (nm^2)	730	1900	3700	5200	1.1×10^4	3.6×10^4
estim. p_0 (mbar)	3×10^{-8}	1×10^{-8}	6×10^{-9}	4×10^{-9}	2×10^{-9}	6×10^{-10}

(handwritten annotations: 1800, $q_\gamma \lambda^2$, 706 nm, 30 nm, $\frac{6 e}{\#} = 51\,!$)

[a] green fluorescent protein
[b] rhinovirus HRV2 S150

TABLE 2   Estimated decoherence pressures of candidates for matter wave interferometry in a stretched Talbot interferometer ($L = 1$ m, $v_m = 10$ m/s) in the presence of air. The effective cross sections are based on reasonable estimates for the polarizability and the effective number of valence electrons

Very high vacuum is needed to preserve coherence of free moving particles (for 30 nm virus it's 10^{-10} mbar). Note that our particles are bound, however, so that this limitation doesn't apply.

Note that if these particles emit photon during their passage – the interference is destroyed. The destruction of the interference occurs, even though the recoil has not changed the "trajectory" in any measurable way....

Sketching the quantum explanation

Wave function from Schrödinger eq. ➜ Probability of detection by interaction
Bound state in a (shallow, less than 0.1 eV) potential well. Exact shape of the well is not
important for explaining the principle
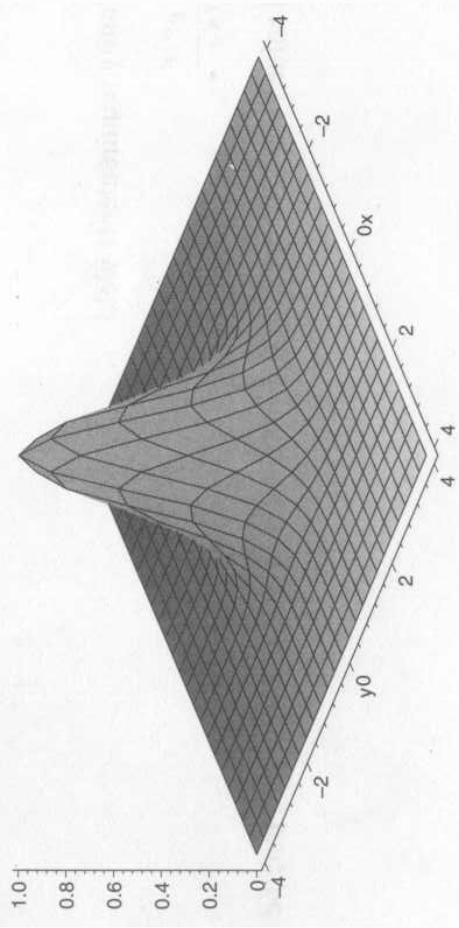
Deformation of potential well (by thermal stresses, for instance) ➜ bound state
approaching zero energy state
Exact zero energy state ➜ constant wave function (not realistic)
The process is not adiabatic (cannot be when passing through zero energy) ➜
it must be a wave packet around the potential well

Situation in a crack is different:

impermeable walls -> wave function goes to zero at the wall
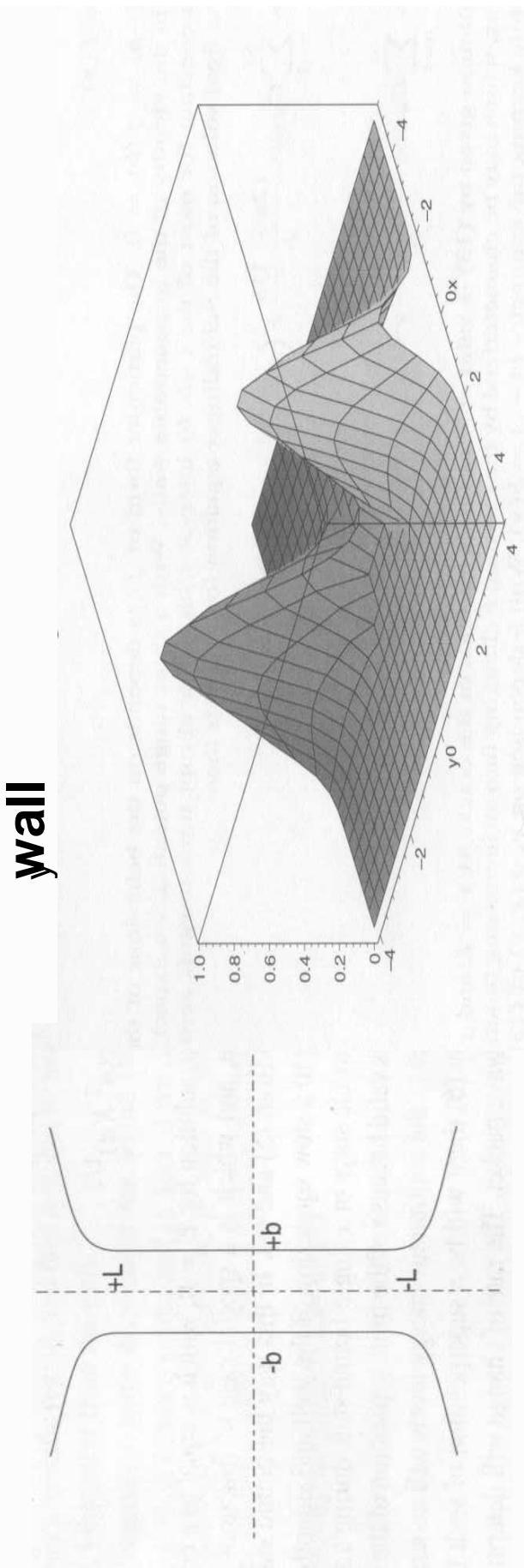
- Schrödinger equation in y-direction has exponential solution instead of sin or cos.

- Where the probability of interaction peaks (at the end of the crack), there the localization occurs; either by falling into a potential well (surfaces of adsorbers), or by being hit by molecules of air (ultrafine aerosols measured in isolated caves).

The cul-de-sac modification of the previous sketch of the crack; clearly it is much more realistic than a symmetric crack
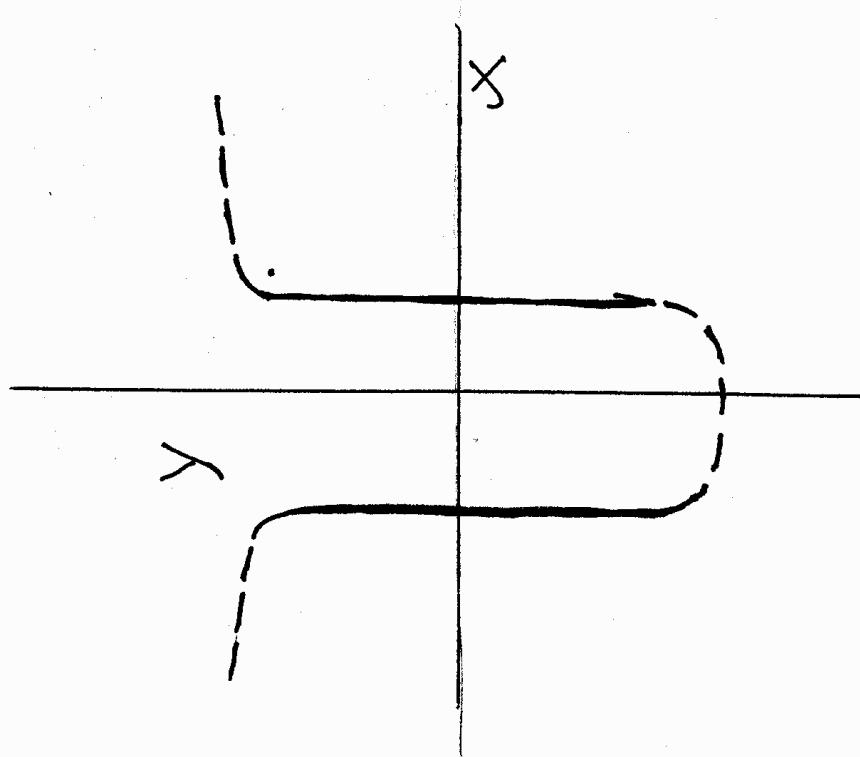
QM is counterintuitive

It is one of the results of QM which goes against "normal" thinking. The error one makes here is that one tends to think of the particle as traveling from the source along all those various potential wells nearby and strangely ignoring them until it is adsorbed by some well far away. But that is not what QM predicts. As the occupied level in the source well rises, the hump of the wave function of the particle grows only outside the crack.

Nevertheless, until it really starts to acquire reasonably large positive exponent, the probability of finding it outside will be very small and nothing happens. The growth of the positive exponent makes the probability grow, but faster in the region that is further away from the source than in the nearby region. So it may not be "realistic" but it is what QM predicts

Recall that the particle is still bound. If it were a free particle, decoherence would take place in about 10^{-13} s.

Is vacuum necessary ?

The impermeable wall is the matter of potential. If the potential is everywhere going to infinity, there is the wall. If there are gaps, the wall is not a wall and the particle can get through. And, due to our mechanism, it will get through with considerable probability. The molecules of air are leaving plenty of gaps and it does not really matter how small they are and even bigger particles can in principle get through. But the solid matter of the walls, discounting for some cracks, does not leave any way through. The potential is such that it rises everywhere. The last but not least – the probability of occurrence of this phenomenon has been estimated as low as 10^{-9}

(Holub & Smrz, 2002)

Barrier penetration?

To say that it is something like a barrier penetration might be a little misleading. In the barrier penetration the particle goes through the forbidden region and materializes (localizes) in the allowed region. If our collapse takes place before the energy reaches zero then it must get energy from a particle with which it interacts, or it must fall into a potential well, possibly remote, to conserve energy. If it materializes after the energy reaches zero or slightly above, then it is a pure collapse, no penetration at all. Whoever knows the usual barrier penetration from QM textbooks may be confused by the comparison. We have no way to establish at what stage collapse takes place. All we know it is found in a remote location. So also talking about imaginary time etc. does not really make sense. Fully accepted theory of the collapse of a wave function does not exist as yet so one cannot say whether it is instantaneous or not.

Nanotubes: why does H_2O move through them so fast? Is something similar taking place in transport of fluids through porous media?

Table 1 | Pressure-driven flow through aligned MWCNT membrane

| Liquid	Initial permeability*	Observed flow velocity†	Expected flow velocity†	Slip length (nm)
Water	0.58	25	0.00057	54
	1.01	43.9	0.00057	68
	0.72	9.5	0.00015	39
Ethanol	0.35	4.5	0.00014	28
iso-Propanol	0.088	1.12	0.00077	13
Hexane	0.44	5.6	0.00052	9.5
Decane	0.053	0.67	0.00017	3.4

MWCNT, multiwalled carbon nanotube. For details of methods, see supplementary information. *Units, cm^3 per cm^2 min bar. †Flow velocities in cm s^{-1} at 1 bar. Expected flow velocity is that predicted from conventional flow.

$$\frac{cm^3}{cm^2\, min\, bar}$$

$$\frac{43.9}{.00057} = 7.$$

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Homogeneous nucleation data and theory disagree 3-5 orders of magnitude, and also in slope. S = saturation; J= flux (Zdimal et al.)
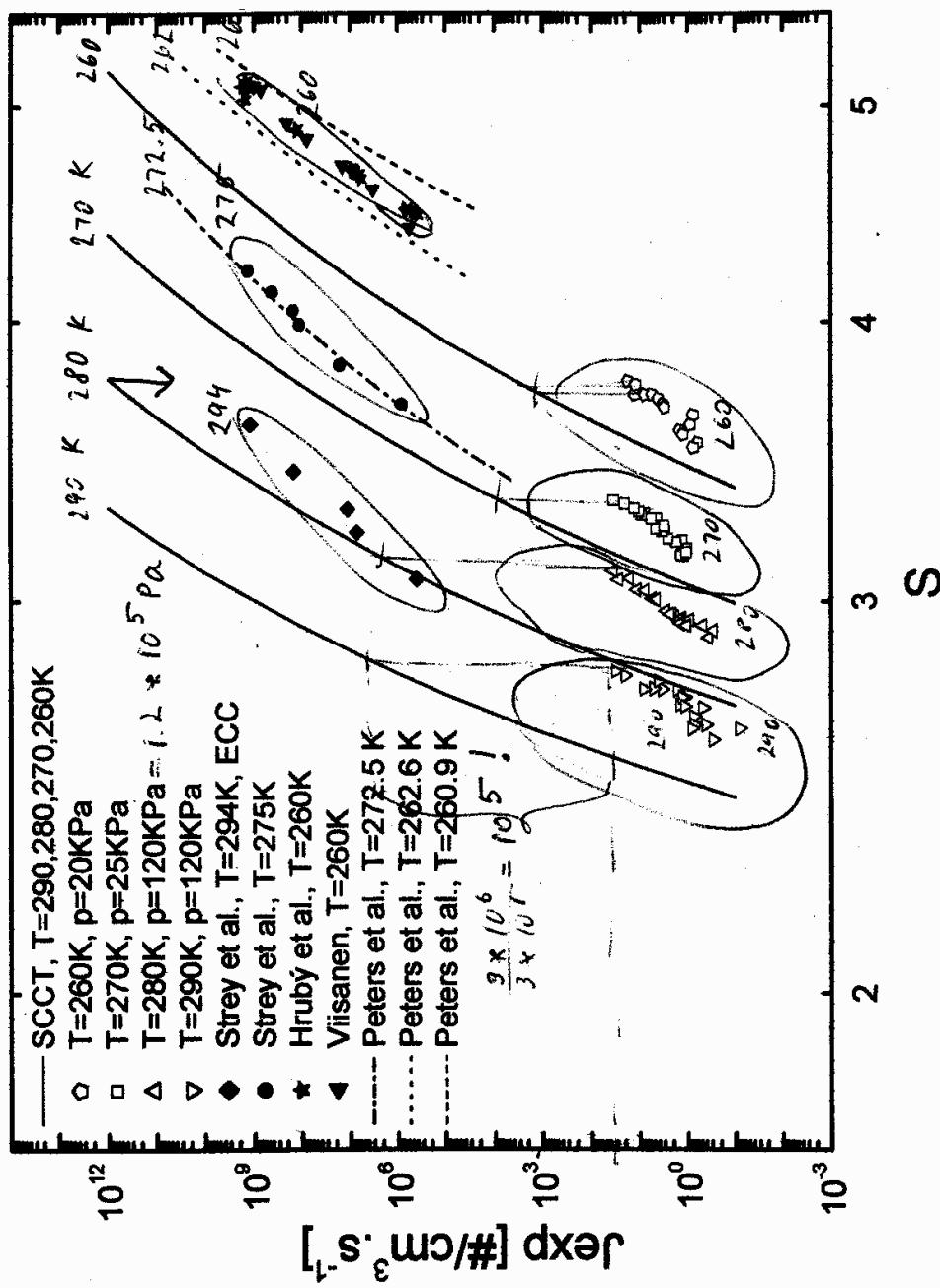
Classical nucleation theory is based on interplay of surface tension , σ, and chemical potentials, u, (either from vapor to liquid or solid, or vice versa (bubbles, voids))

- $\Delta G_i = (u_l - u_v) \; i + 4\Pi\sigma r^2$

- $\Delta G_i = (u_v - u_l) \; i - (p_v - p_l) \; V + 4\Pi\sigma r^2$

where p is pressure, r diameter of droplet (bubble), of the ith polymer, i number of molecules transferred from gas phase, etc.

The reason for the disagreements appears to be that the (quantum) surface effects are incommensurate with such classical bulk approach.

More detailed (preliminary) list of possible reasons for the problems with nucleation theories

- 1. similar to "superfast" flow through nanotubes, fingering etc., there are (3-D, quantum) jumps of unknown lengths, on all surfaces, of walls and of impurities, taking place, at unknown rates

- 2. surface diffusion may not be only on surface, but even away from it… (recall the all paths Feynman interpretation of QM)

- 3. coagulation of three molecules constitutes condensed/solid state; such trimers represent a large surface area… is that aspect properly taken into account?
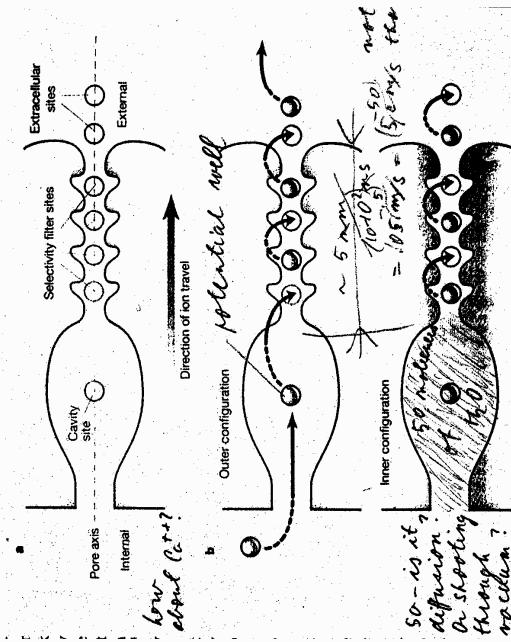
Contd….

- 4. a possible appearance (localization) of our particles (from far away places) on trimers further confounds the situation

- 5. surfaces of vessel walls are not smooth; there is a large surface to volume ratio at nanoscale sizes, further perturbing the classical bulk approach

NOTE THAT POTASSIUM IONS, also moving very fast through their channels, ARE SHOWN AS BALLS

If we take QM seriously, we should object to depicting the K+ as having defined trajectories. Yet, all molecular biology is based on "balls and sticks".

Even when wave function calculations are used (like in Density Functional Theory), shallow potential wells (<.1 eV), located in cracks, are rarely considered

sium run "NOBEL PRIZE ARTICLE"
ATOMIC NANOSCOPE

nbranes spanned by potassium-conducting channel your nerves (and much else) simply wouldn't work. these channels can now be seen in dazzling detail.

Figure 1 Permeation of K+ ions through the pore of a K+ channel, as surmised from the new results[1-3] discussed here. a, There are seven main sites for ions along the pore axis: one in the pore cavity, four in the selectivity filter and two just beyond the external end of the pore. The cavity site is fully occupied, but (as indicated in b) only half of the remaining six site are occupied at any one time. b, The two main ion configurations, known as outer and inner, that are postulated to exist within the pore. Purple arrows indicate ion shifts that are linked directly to concerted ion entry into and exit from the pore. Red arrows represent shifts within the pore without ion entry and exit. As shown here, then, ion passage through the selectivity filter and extracellular sites occurs in bucket-brigade fashion.

HOW ENERGIES FROM BENDING, FRACTURES, OF CHEMICAL BONDS, AND THE THERMAL ENERGY AT ROOM TEMPERATURE, ARE SIMILAR IN SIZES 0.1 TO 30 nm (from A.Philips & S.R.Quake, Phys.Today,May-06)
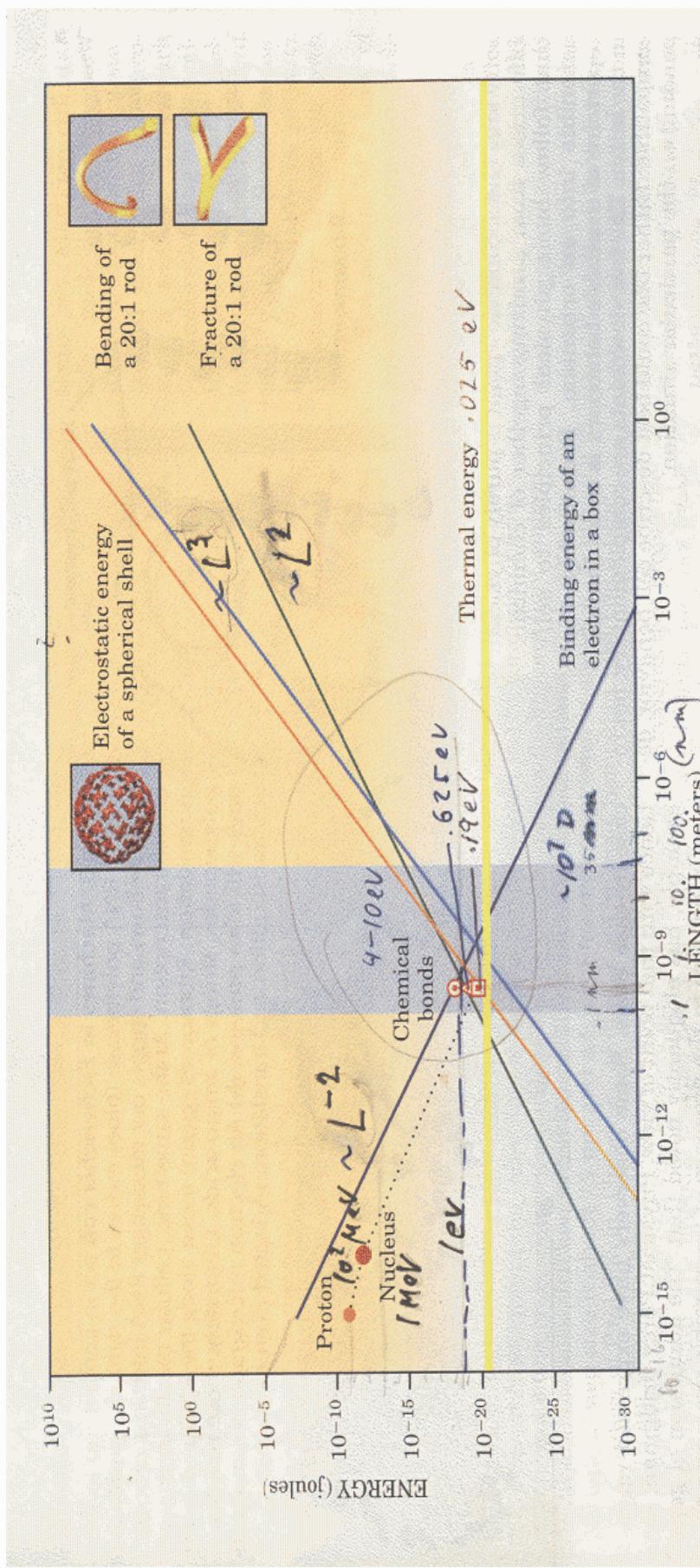

Figure 2. The confluence of energy scales is illustrated in this graph, which shows how thermal, chemical, mechanical, and electrostatic energies associated with an object scale with size. As the characteristic object size approaches that at which molecular machines operate (shaded), all the energies converge. The horizontal line shows the thermal energy scale kT which, of course, does not depend on an object's size. We estimate binding energy (purple) by considering an electron in a box; for comparison, the graph shows measured binding energies for hydrogen bonds (square), phosphate groups in ATP (triangle), and covalent bonds (circle), along with characteristic energies for nuclear and subatomic particles. In estimating the bending energy (blue), we took an elastic rod with an aspect ratio of 20:1 bent into a semicircular arc, and to compute the fracture energy (green) we estimated the energy in chemical bonds in a longitudinal cross section of the rod. The electrostatic energy (orange) was obtained for a spherical protein with singly charged amino acids of specified size distributed on the surface.
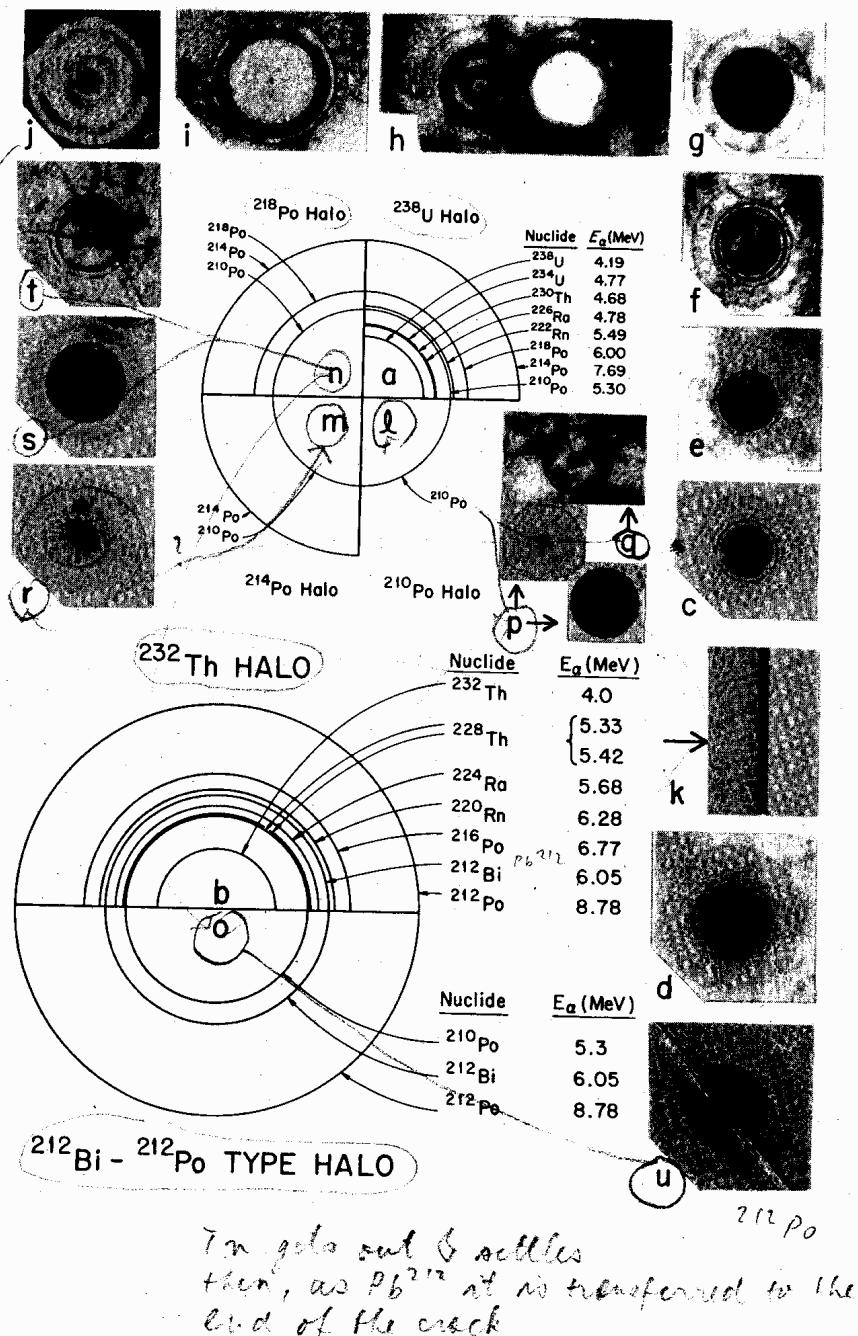
1 ppm accuracy in cell communication is not understood

- Diffusion and diffusion-reaction cannot explain such accuracy. Is our macroscopic quantum effect a possible explanation? (a speculation)

- The key is the idea of "macroscopic quantum receptor". Receptor in biology is that only one particle fits into into a site

- Our macroscopic wave function could scan large segments of cells...

Contd..

- Due to Pauli exclusion principle each particle wave function "knows" where it can or cannot go

- Assuming there are numerous (our) macroscopic quantum particles in a cell (a many body system), such cell would be a communication unit…

ALPHA HALOS, FROM ALPHA RANGE CURVES, GIVE DATA ON WHAT WAS HAPPENING THROUGH Gy OF EARTH HISTORY, IN ROCKS CONTAINING TINY CRYSTALS OF U AND Th

218Po Halo   238U Halo

218Po
214Po
210Po

Nuclide	E_α(MeV)
238U	4.19
234U	4.77
230Th	4.68
226Ra	4.78
222Rn	5.49
218Po	6.00
214Po	7.69
210Po	5.30

210Po

214Po
210Po

214Po Halo   210Po Halo

232Th HALO

Nuclide	E_α (MeV)
232Th	4.0
228Th	5.33 / 5.42
224Ra	5.68
220Rn	6.28
216Po	6.77
212Bi	6.05
212Po	8.78

Nuclide	E_α (MeV)
210Po	5.3
212Bi	6.05
212Po	8.78

212Bi - 212Po TYPE HALO

Th gets out & settles then, as Pb212 it is transferred to the end of the crack
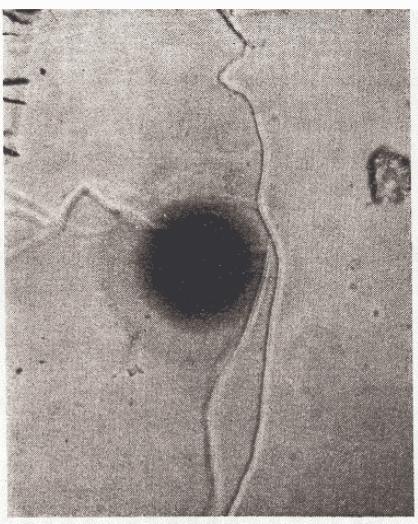
212Po

Po HALOS THAT CLEARLY SHOW ABSENCE OF U AND LOWER ALPHA ENERGY EMITTERS

The puzzle is that Po isotopes have 3.05 min, 28 min, and 138 days half-lives:

They cannot be there very long….How did they get there?

Fig. 3. Uranium halo (×375).

Fig. 4. Thorium halo (×375).

Po HALOS HAVE NO TRACES OF U OR Th AND HIGHLY ANOMALOUS Pb ISOTOPE RATIOS
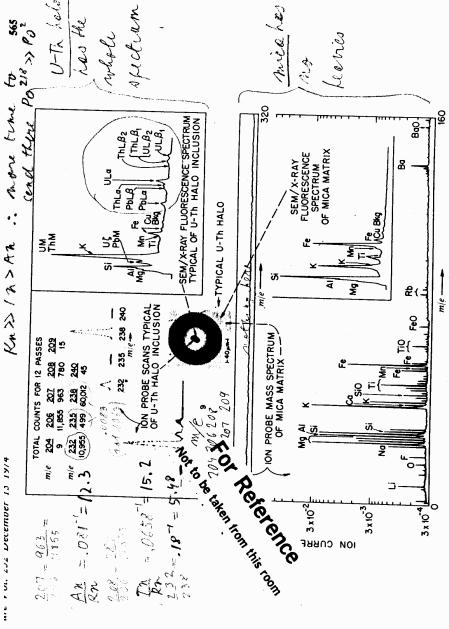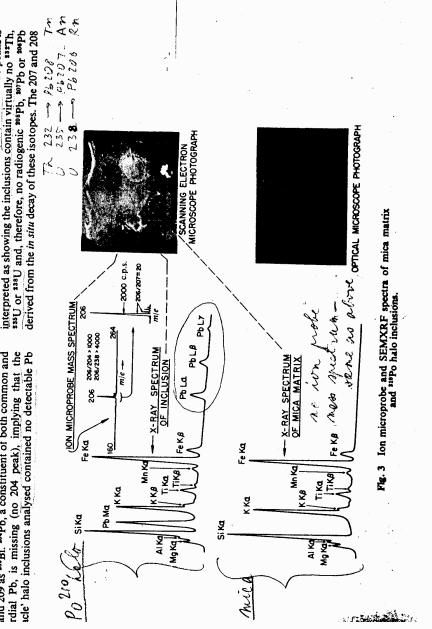
The absence of U and Th in the halos, determined by two methods, proves beyond doubt that Po atoms (at least 10e8 of them) had to get to their sites practically instantaneously - via nanocracks (invisible to optical microscopes)

WHAT IT IS NOT

Contamination or faulty electronics

That most elements in the periodic table can form volatile (gaseous) compounds (with water molecules)

That aerosols are carried by geogas through geological faults from depths (it is a fact they cannot penetrate through earth and filters without getting stuck on surfaces)

That thermal rebound is responsible for a (necessarily very slow and rare) transport through soil, rocks and filters

That volatile organometallics, which penetrate through rocks, soil and filters, are stable gases: the carbon-metal bond is weak or unstable (except for Hg and a few others)

SUMMARY

1. The evidence is convincing that anomalous transport of particles (basically of all elements of the periodic table), over large distances, and through rocks, soil and impenetrable filters, does take place

2. The nature of the transport is such that apparently it has to be practically instantaneous; the only transport in nature that conforms to that is the collapse of the wave function

3. The Schrödinger equation says that at zero energy the wave function of a bound particle, with the boundary conditions that confine the wave function into a crack with impermeable walls, peaks at the end(s) of the crack

4. Because the particle is bound, its decoherence doesn't occur in 10^{-13} s but has probably higher than 10^{-9} probability to survive and undergo the mechanism suggested here

5. The observed data conform reasonably well to such scenario; we propose, and hope that others will test this hypothesis, that 'geoaerosols' are transported via the macroscopic quantum effect described here

Future plans and prospects

- Finish publishing the data collected in 2002-present (some shown here for the first time)

- Write papers on individual anomalies on the 15 item list, with authors who are experts in given fields (for instance, with M.Benes' group on transport of fluids through nanocracks, and so on).

- Keep trying convincing others there are real anomalies that have to be recognized as such.

- Perform time dependent density functional theory (DFT) calculations (employing intermolecular forces rather than the usual chemical and ionic ones), in crack geometries etc.

- Keep writing proposals while keeping in mind that having the scientific community accept radically new ideas is hard

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