acetylase activity was found in guinea-pig ileum homogenates, the possibility of ACh synthesis during the assay was also tested. No evidence of measurable ACh synthesis was found when choline and acetyl CoA (SCHUBERTH et al.[5]) were added in the bioassay bath at levels normally found in brain samples of the size we used nor after repeated additions over a normal work period. These checks plus those used in the original study (TORU and APRISON[1]) suggest strongly that the higher values of ACh obtained with the formic acid-acetone extraction solution are true values.

Table II. *ACh concentrations (nmoles/g) in the brain white matter of guinea-pig*[a] by 2 extraction procedures

| Experiment No. | Acid-ethanol | Formic acid-acetone |
|---|---|---|
| 1 | 6.11 | 8.97 |
| 2 | 6.82 | 6.94 |
| 3 | 5.17 | 5.50 |
| 4 | 4.51 | 6.55 |
| 5 | 3.25 | 6.99 |
| 6 | 4.29 | 5.67 |
| 7 | 3.08 | 7.32 |
| Mean ± S.D. | 4.73 ± 1.13 | 6.82 ± 1.15 |
| | $P < 0.01$ | |

[a] 2 or 3 animals (weighed between 600 and 1000 g) were used in each experiment.

*Zusammenfassung*. Eine stark verbesserte Methode zur Extraktion und damit zur Bestimmung von Acetylcholin in der weissen Substanz von Ratten- und Meerschweinchengehirn, die bis zu 20–40% höhere Werte ergibt als die bisherigen Verfahren, wird beschrieben.

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DISPUTANDUM

## Fluid-Drop as a Cosmological Model:

1.1. *Qualitative observations on discontinuous evaporation of certain fluid systems.*

In the course of routine biological techniques, while warming drops of certain biological stains on a glass slide, some curious patterns of their discontinuous evaporation can be observed. If these observed patterns can be extrapolated to cases of freely suspended static or rotating spheres of the fluid system, this leads to very curious iso-morphic or homomorphic analogues which seem to be repeated, apparently at various levels of cosmological hierarchies. Therefore, a possibility of examining such fluid drops as a cosmological model has been tentatively indicated. However, the author as a biologist can only restrict himself to mere qualitative observations and concepts with a hope that some physicists and cosmologists may like to re-examine this case more critically and quantitatively.

Cosmological enquiries necessarily go beyond the limits of direct objectivity or precise measurements[1]. In this sense, cosmology has to be more or less speculative with its usual reliance on models, analogies or bisociations as initial starting points for further enquiries through prediction, observation and verification or falsification. Even mathematicians like Laplace have deliberately preferred to be purely qualitative while proposing their cosmological conjectures. Modern cosmology has been trying to be more quantitative and exact within a limited[1] scope. But even in these cases, pure qualitative hypothetical concepts first precede and then motivate any such quantitative attempts. History of science presents several cases of pure concepts or qualitative observations which were quantitatively treated much later by someone else. Prout's Hypothesis or Brownian Motion may serve as examples. It was a *biologist* who first reported his simple qualitative observations on Brownian motion, later to be examined by Einstein, Perrin, Wiener and other physicists and mathematicians until it developed into the modern theory of probabilistic potential[2].

It is hoped that conspicuous absence of any quantitative approach in the following pages may be received in this perspective.

1.2. In earlier communications[3,4] it has been shown that evaporation of drops of certain liquids and consequent reduction in drop diameter does not occur as a continuum process. It proceeds in discrete discontinuous steps. If a drop of a biological stain like propiano-carmine (0.3% carmine in 45% aqueous propionic acid) is placed on a horizontal glas-slide and allowed to evaporate slowly by gentle heat, reduction in its diameter occurs in discrete steps due to discontinuous emission of the solvent phase (45% propionic acid) in sequential series of discrete fractions or serial quanta as ($Q1 \rightarrow Q2 \rightarrow Q3, \dots QL$),

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automatically recorded by a parallel process of correspondingly rhythmic sedimentation of the solute phase (carmine) in concentric rings as

($D1 \rightarrow D2 \rightarrow D3, \ldots DL$) separated by blank intervals
($I1 \rightarrow I2 \rightarrow I3, \ldots IL$) at corresponding time intervals
($T1 \rightarrow T2 \rightarrow T3, \ldots TL$) respectively (Fig. 1-1 to 1-6).

1.3. If this evaporation occurs at higher temperatures approaching boiling point, the concentric rings mainly consist of thick $D$ lines as $D1 \rightarrow D2 \rightarrow D3, \ldots DL$ (Figure 1-4 to 1-6). If the evaporation proceeds at medium temperature, serial $D/D$ lines or intervals are resolved into a series of thinner $d$-lines (Figure 1-7 to 1-11) due to slow evaporation in smaller fractions or steps as:

$$D1 \rightarrow \underset{1}{d1} \rightarrow \underset{2}{d1} \rightarrow \underset{3}{d1} \ldots \underset{L}{d1} \rightarrow D2$$

$$D2 \rightarrow \underset{1}{d2} \rightarrow \underset{2}{d2} \rightarrow \underset{3}{d2} \ldots \underset{L}{d2} \rightarrow D3, \text{ etc.}$$

If this evaporation proceeds at still lower or room temperature, the above $d/d$ lines or intervals are further

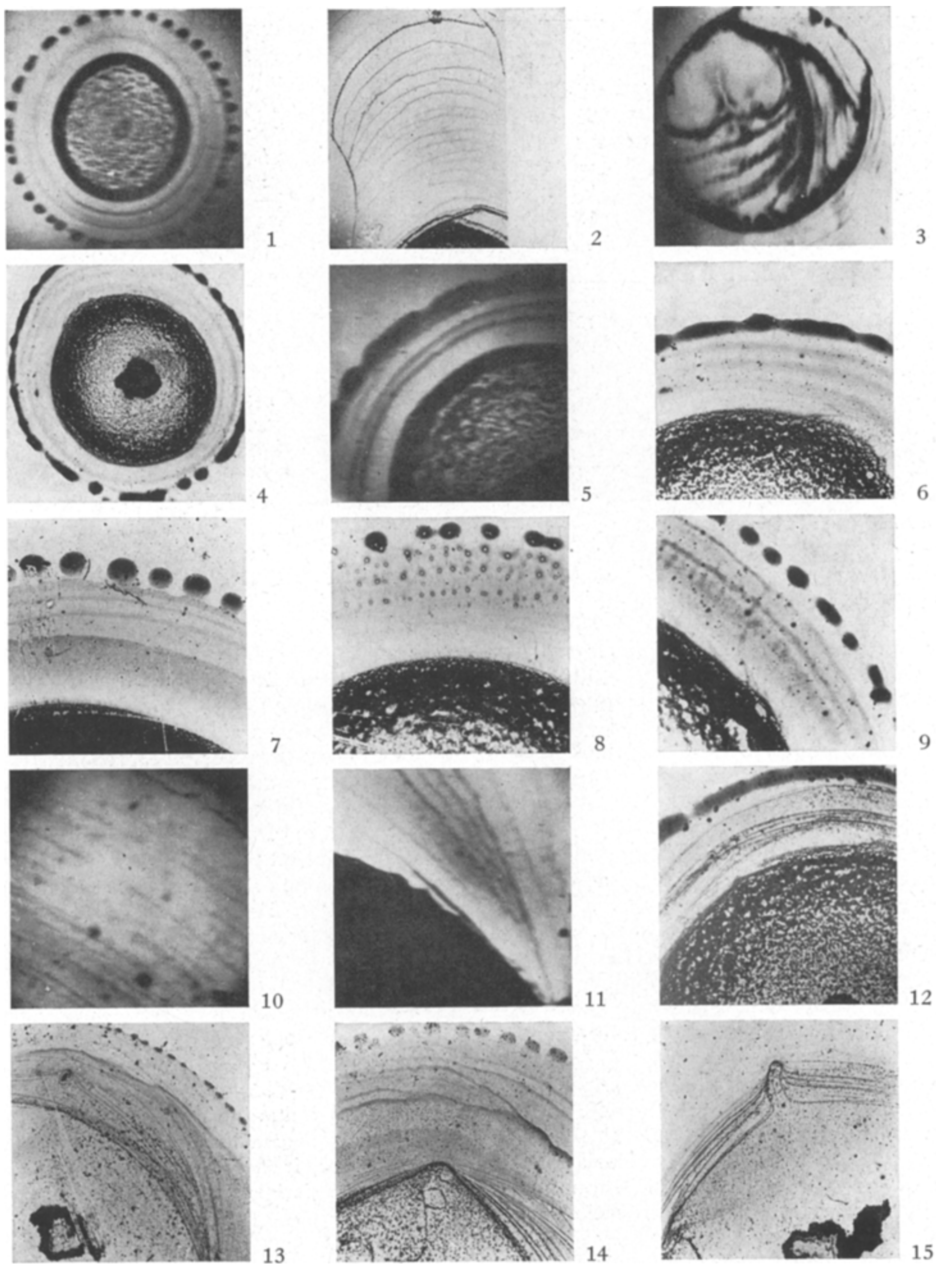

Fig. 1. (1) Regular concentric sedimentation pattern on horizontal surface. (2) Discontinuous sedimentation on inclined surface. (3) Irregular discontinuity pattern with shifting inclinations of the surface. (4–7) Discontinuous sedimentation in concentric $D$-bands at higher temperatures. (8–11) Resolution of concentric $D$-bands into $d$-lines at medium temperatures. (12–15) Further resolution of $d$-lines in finer $\Delta d$-lines. (14–15) Initiation of radial channel of streamers or faculae for ejection of hot solvent phase during implosion.

resolved into component lower series of still finer $\Delta d$-lines (Figure 1-12 to 1-15) as:

$$d1_{1} \rightarrow \Delta d1_{1.1} \rightarrow \Delta d1_{1.2} \rightarrow \Delta d1_{1.3} \ldots \Delta d1_{1.L} \rightarrow d1_{2}$$

$$d1_{2} \rightarrow \Delta d1_{2.1} \rightarrow \Delta d1_{2.2} \rightarrow \Delta d1_{2.3} \ldots \Delta d1_{2.L} \rightarrow d1_{3}, \text{ etc.}$$

1.4. Since the blank intervals separating adjacent $D/D$, $d/d$ or $\Delta d/\Delta d$-lines correspond with the fraction ($Q$, $q$ or $\Delta q$) of solvent phase emissions at respective levels, this discontinuous or quantized evaporation of the solvent phase may be generalized as:

$$Q1 \rightarrow Q2 \rightarrow Q3 \ldots QL$$

$$Qn = qn_{1} + qn_{2} + qn_{3} \ldots qn_{L} \rightarrow Qn + 1$$

$$qn_{x} = \Delta qn_{x.1} + \Delta qn_{x.2} + \Delta qn_{x.3} \ldots \Delta qn_{xL} \rightarrow qn_{x+1} \quad \text{etc.}$$

This suggests that each quantum state may be subquantized into component lower order series or sets, in-

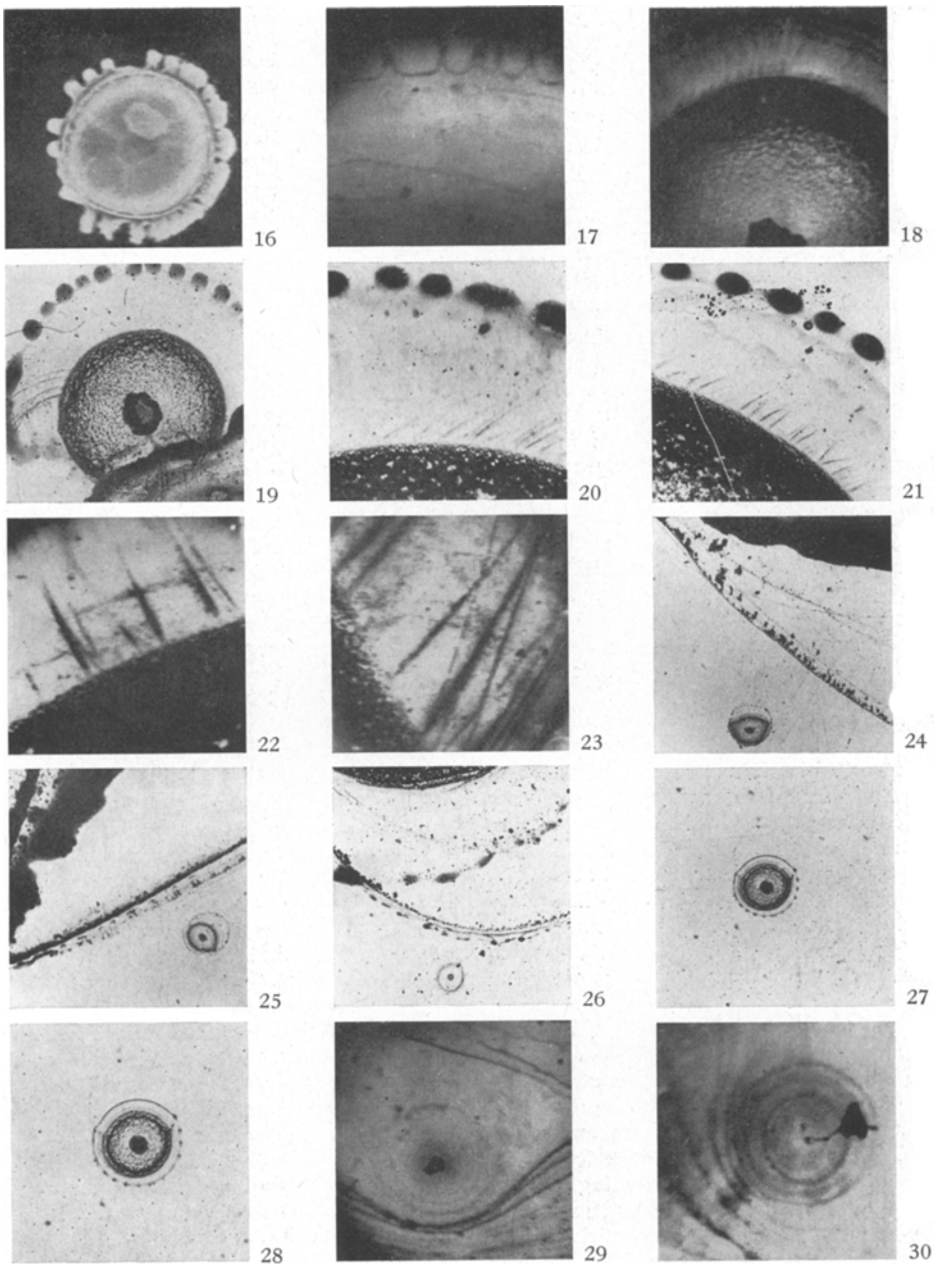


Fig. 2. (16) Radial streamers forming peripheral droplets around their parent drop. (17) Radial faculae for ejection of solvent vapours. (18) Radial flares (at 12 o'clock position) for ejection of hot gaseous solvent phase. (19–23) Radial jets for forceful ejection of hot gaseous solvent phase at higher temperatures; jets at various magnifications. (24–30) Major parent drop splitting or spurting into minor droplets and both showing qualitatively similar concentric sedimentation patterns due to discontinuous evaporation of the solvent phase; parent-drops and their droplets at various magnifications.

definitely, thus sharing apparently, some of the features of the Cantor series.

Just for the sake of convenient expression, the term 'quantum' is employed here not in its conventional micro-physical context but in a very general sense so as to imply 'a part of the whole' or a discrete fraction of the fluid-drop macro-system.

1.5. The last member ($QL, qL, \Delta qL$) within respective sets is preceeded by a series of pulsations in the fluid-drop, each consisting of coaxially symmetric radial expansion and contraction resembling peristalsis. These may be called 'pulsating transitions' during such discontinuous evaporation of a fluid-drop.

1.6. A serial succession of such pulsating transitions finally culminate into the last member ($QL$ or $qL$ or $\Delta qL$) which occurs as an abrupt unilateral implosion or a sudden cataclysmic collapse into the first member of the next series or set, as for instance:

$$(D1 \rightarrow \underset{1}{d1} \rightarrow \underset{2}{d1} \ldots \underset{L}{d1} \xrightarrow{\text{collapse}} D2 \ldots), \text{ etc., or}$$

$$(\underset{1}{d1} \rightarrow \underset{1.1}{\Delta d1} \rightarrow \underset{1.2}{\Delta d1} \ldots \underset{1.L}{\Delta d1} \xrightarrow{\text{collapse}} \underset{2}{d1} \ldots), \text{ etc.}$$

thus repeating a similar sequence of serial pulsations leading to serial collapses.

1.7. Each of these collapses or an implosion is associated with a sudden emission of the solvent phase (45% propionic acid) by means of forceful radial gaseous jets, flares, faculae or mild streamers depending on the temperature of evaporation (Figure 2-16 to 2-23).

1.8. Such serial step-wise emission of all the solvent phase (45% propionic acid) in such discrete quanta finally leaves behind sediments of the solute phase (Carmine) in concentric $D$, $d$ and $\Delta d$ rings, enclosing a very dense central core with tunicate iso-density contours resembling Liesegang Rings (Figures 1-4, 1-6, 1-12, 1-13; 2-19).

1.9. If a parent drop splits or spurts into minor droplets, independent discontinuous evaporations in all of them finally leave behind qualitatively similar concentric patterns as above, *irrespective of their relative sizes* (Figure 2-24 to 2-30).

1.10. This dynamic sequence of discontinuous evaporation of the solvent phase in serial successions possibly suggests correspondingly alternating phases of balance and imbalance states between the following opposite interacting forces: (a) rise in temperature and internal gas-pressure tending to burst the drop, and (b) surface-tension, cohesion and gravity together opposing the rupture of the drop.

These opposite forces may interact in 3 cyclically reversible phases as:

$$(a < b) \rightleftharpoons (a = b) \rightleftharpoons (a > b)$$

Serial succession of such cyclic sequences may cause $Q$, $q$, $\Delta q$ emissions of the solvent phase and $D$, $d$, $\Delta d$ sedimentations of the solute phase in concentric rings as above.

1.11. The solvent phase consisting of 45% propionic acid in this case is heterogenous (acid/water) which may also influence this discontinuity. Uni-, bi- or multi-component conditions of both solvent and solute phases, their relative proportions, solubilities, specific heats, boiling points, partial vapour pressures, evaporation temperatures, surface tensions, inter-facial frictions, etc., may influence any possible variations in this basic pattern of discontinuous evaporation. It is necessary to collect quantitative data on relative parameters for ($D$, $d$, $\Delta d$), ($Q$, $q$, $\Delta q$), ($I$, $i$, $\Delta i$) and ($T$, $t$, $\Delta t$) in the context of various combinations of the above variables, for a further critical insight in this basic qualitative pattern of discontinuous evaporation.

1.12. *Some generalized extrapolations for freely suspended static or rotating fluid spheres.*

A fluid-drop resting on a glass-slide in the above case assumes a plano-convex discoid form. We may visualise similar quantized evaporations from a *static* sphere of the same fluid system freely suspended in space.

Quantized emissions ($Q$, $q$, $\Delta q$) of its solvent phase may be released in the rest of the exterior space in the form of gaseous hollow spheres ever expanding and rarefying in space. Sedimentations of the solute phase may occur in concentric ($D$, $d$, $\Delta d$) spherical shells enclosing a dense central solid core with tunicate iso-density contours. The resulting pattern of concentric spherical shells may be analogous to Shell-stars such as P-Cygni, R-Coronae Borealis or W-stars.

If such a freely suspended fluid-sphere assumes *axial rotation* causing equatorial bulging and polar flattening proportional to its angular velocity, the same system may present itself as a bi-convex rotating disc. It is already known that a progressive increase in its angular momentum and polar flattening beyond a critical threshold for (polar/equatorial) ratio, should lead to an ejection of equatorial rings.

However, quite apart from such a possibility or even independently of it *without necessarily presuming any increase in angular momentum* beyond the critical threshold, just by cyclic rise and fall in its internal temperature and pressure as indicated (1.10), this rotating discoid fluid system may possibly undergo a series of quantized emission ($Q$, $q$, $\Delta q$) of its solvent phase lost into exterior space.

This may simultaneously deposit sediments of its solute fractions in concentric, coplanar, equatorial rotating rings ($D$, $d$, $\Delta d$) enclosing a dense central core with reduced diameter as observed in the above case of a fluid-drop.

Original angular momentum of the fluid proto-disc may then be partitioned among (a) ever-expanding and rarefying gaseous emissions of the solvent phase lost in space, (b) equatorial, coplanar, concentric rotating rings of the solute sediments, and (c) a relatively small fraction of the original angular momentum retained in the dense central core with its reduced diameter.

Solute particles in the equatorial coplanar rotating rings may suffer collisions, coalesce and undergo gravitational accretions into minor spherical or discoid satellites possessing both an axial rotation as also an orbital velocity.

The central residual proto-disc as also its primary satellites in concentric coplanar orbits as above, may subsequently behave similarly in respect of discontinuous emissions of their respective residual solvent phase and concentric sedimentation of their solute phase, analogous to the qualitative identity of concentric sedimentation patterns produced by a parent drop and its minor droplets as observed (1.9) (Figure 2-24 to 2-30).

By this process, there will be (a) a progressive increase in the number of primary satellites around the central proto-disc, and (b) each primary proto-satellite may then form its own secondary satellites with concentric orbits around the respective primaries, until all its solvent phase residues are exhausted.

Systems so far considered involve discontinuous *emissions* of the substrate solvent phase associated with serial pulsating transitions culminating in a sudden collapse or an implosion as observed (1.5 and 1.6).

We may visualize a reverse situation of a freely suspended highly *hygroscopic* fluid sphere *imbibing* its aqueous solvent substrate from its surrounding moist space super-saturated with humidity.

Such a system may show a preceeding series of radial perturbations or pulsating transitions culminating in a *sudden-swell* of the sphere diameter in discrete ascending $\Delta d$, $d$ or $D$ steps corresponding with its *discontinuous imbibation* of the solvent phase in discrete $\Delta q$, $q$ or $Q$ quanta or fractions from the exterior space. These sudden swells in diameter in discrete steps may resemble discontinuous imbibation of liquids during the process of pino-cytosis so common in cell biology.

Therefore, contracting or expanding fluid spheres may reciprocally interact with the rest of the exterior space in discontinuous discrete steps in a manner implied in the extended concept of Lagrangian Displacements or the Mach's Principle.

The above general pattern of discontinuities in the fluid-drop obviously suggests some curious iso-morphic or homo-morphic analogues which are consistently repeated at various levels of micro- to macro-cosmic hierarchies. In the course of subsequent papers, these analogues will be presented and possibilities of considering such fluid-drops as a cosmological model will be explored.

*Discussion.* Liquid-drops or fluid-spheres have already been employed as models for exploring some cosmological problems. Classical observations of PIERRE SIMON and PLATEAU on rotating oil-spheres suspended in water, or the experiments of SIR JAMES JEANS on rotating gas spheres, have provided very useful models and analogies for our understanding of various cosmological problems such as flattening of galactic poles or emission of equatorial rings at critical threshold values for their angular momentum and axial ratios. This has made it possible to interpret tentatively some of the observed galactic patterns. CHANDRASEKHAR[5] has analyzed theoretical equilibrium and stability conditions for self-gravitating liquid ellipsoids under (a) Riemannian irrotational sequence, (b) Dedekind sequence for stationary ellipsoids with internal motion of uniform vorticity, and (c) Jacobian sequence for uniformly rotating fluid ellipsoids. This analysis can be extrapolated to various analogous cosmological situations. ALFVEN[6] has tried to defend Klein's hypothesis of anti-matter cosmology by invoking an analogy with a liquid sphere kept unboiling over a superheated concave surface (Leidenfrost phenomenon). It is thus quite common to employ various aspects of fluid-drop behaviour for building cosmological models.

In the particular context of the contemporary problem of galactic implosions, various models of imploding fluid-spheres are being examined in the light of (a) the classical Newtonian hydrodynamics alone as also (b) by incorporating in it the general relativity concepts. MCVITTIE[7] has shown that the former leads to a *continuous implosion* at the critical threshold limits for specific heat of the system. CHANDRASEKHAR[8] has indicated that the latter treatment under general relativity involves introduction of baryon-conserving perturbations preceeding an actual implosion or gravitational collapse. This second situation appears to have its *partial* analogues in the form of symmetric pulsations or perturbations just preceeding an implosion of the fluid-drop (1.5 and 1.6). But in the present case the implosion itself has been observed to occur in finite discrete radial steps. HOYLE, NARLIKAR and WHEELER[9] as also NARLIKAR[10] have indicated the limitations of the general relativity for understanding the problem of instability of galactic masses approaching Schwarzchild limits and their implosion leading to singularity. BONDI[11] has classified various such cases under both Newtonian and general relativistic premises. Some of these alternative oscillating models do not contract to singularity but only to a finite radius and re-expand. WHEELER et al.[12] suggest that a quantum transition from collapse to expansion may take place without continuous culmination into singularity. In this context, WHEELER employs an analogy of the 'tunnel effect' during quantum shifts in the electronic energy levels. These analogies proposed by WHEELER[12] are in consonance with the present observations on fluid drops, which provide a concrete demonstration of the sequence of events leading to a serial succession of finite implosions.

By normal standards of exactitude of the exact sciences, analogies hardly have any significance. But cosmology has to be more or less speculative with very cautious reliance on models, analogies, bisociations, conjectures and even thought-experiments, if cosmological enquiries should continue at all. Thus for instance, most of the theories for the origin of our solar system are, more or less, frankly qualitative concepts or conjectures which have yet to be verified quantitatively. In a similar manner and subject to the same limitations, it will be shown that the present observations on discontinuous evaporation of fluid-drops, can provide us with one more model for a possible origin of the solar system, not as an isolated accident as presumed in Kant-Laplace-Weizsäcker hypothesis, but as a part of an orderly general process apparently repeated at various levels of macro-cosmic hierarchies. Individual components of the discontinuity patterns as actually observed (1.3 to 1.8) also have their corresponding iso-morphic or homo-morphic analogues consistently repeated from micro- to macro-physical levels. This by itself is rather curious and deserves our open-minded objective exploration for any possibilities of some *unified* cosmological model. Whether this model may have any such significance at all can only be decided through predictions, observations and verifications or falsification as usual. Various macro- and micro-physical analogues of the fluid-drop model will be objectively presented in the course of subsequent communications.

*Résumé.* L'évaporation des gouttes fluides de certaines solutions s'opère par saccades dues aux émissions radiaires, discontinues de la phase dissolvante. Il en résulte la formation d'anneaux concentriques de sédimentation autour d'un noyau central dense.

En extrapolant les exemples de discontinuité au cas de sphères fluides librement suspendues, statiques ou rotatives, on constate de curieuses analogies passant du micro- au macro-cosmique. Il en sera question dans une prochaine communication.

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