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Concept of Capillary Collapse in Air Space

Yildirim CINAR
Department of Internal Medicine,
University of Trakya, Faculty of Medicine,
Edirne, 22050, Turkey
cinary47@gmail.com

***Abstract*—The aim of the Study was measuring the effects of narrowing capillary interspaces on a weighing mass with certain planar surface. Method: Distillate water (201g) and glass plates (2x125x57 mm, and 37502mg) were weighed with electronic scale separately. A stage of micrometer mobilized one glass plate and later the glass cube (133x125x57 mm, and 250988mg) to create a capillary interspace (width <1mm) on the weighing objects. Changing amounts of weights were recorded as results. Result: Weights of the glass plate and water were decreased 10 mg (1.40mg/cm^2) and 8mg (1.12 mg/cm^2) by capillary interaction like a force of attractions respectively. Discussion: When planar and parallel two objects close to each other within capillary distance in air, a weight decreasing effect develops that calculable as attraction force and drives them to connect (capillary collapse). This is bigger than the gravitational force, less than the force originated from atmospheric pressure, depends to chemical compositions, and increases by decreasing width of capillary. Therefore, the capillary collapse and gravitation could be complicated to each other. This result must be considered in search or analysis of process at the capillarity. New researches are required to explore relationships between this force, distance and chemical composition.**

Key words: Capillarity, Capillary pressure, Capillary gravitation, Capillary blood flow, Capillary collapse, Capillary interaction, Capillary depression.

I. INTRODUCTION

The aim of the study is measuring the effects of narrowing capillary interspaces on a weighing mass with certain planar surfaces.

A. Capillary Effect or Capillarity

The famous effect of surface tension is the ability of a liquid to rise inside narrow (capillary) pipes in apparent violation of the response to gravity. This case is called capillary effect or capillarity. The capillarity is explained by concepts of surface tension, cohesion, adhesion, and gravity. Two attractive forces of them are opposite to each other: adhesion between the molecules of the liquid and those of the container, and cohesion between the molecules of the liquid. If molecules of liquid (like as water) are more strongly attracted to inner surface of a tube (adhesion) than to other nearby liquid molecules (cohesion), the liquid will rise in the tube and forms a concave surface (meniscus). If molecules of liquid (like as Mercury) are less attracted to the tube than to other liquid molecules, the liquid will depress by a convex surface [1, 2]. Mathematical evaluation of the capillary interaction suggests that a narrow tube will withdraw a liquid column higher than a wide tube [3].

B. Practice of Capillary action

Chemists utilize capillary action in paper chromatography, in which a solvent moves vertically up a plate via capillary action. Dissolved solutes travel with the solvent at various speeds depending on constitutional features of solutes, solvents, and papers. Paper blotters, towels, and wicks absorb liquid through capillary action, allowing a fluid to be transferred from a surface to the capillary interspaces of construction [4]. The small pores of a sponge act as small capillaries, causing it to spontaneously absorb a comparatively large amount of fluid by expanding volume [5].

Determination of the volume of packet erythrocytes (hematocrit) can be accurately performed on capillary; blood from a skin puncture wound flows spontaneously into a capillary tube (75 mm length with a diameter of 1.2 – 1.5 mm) by simple connection of blood [6]. Mechanists are using paper separators between glass plates to avoid contact and capture (stick) phenomenon of them, and it is not a real stick or a chemical interaction. The pressure of gas is related by collisions between surfaces and gas molecules, and the force of capture phenomenon is explained by zero air pressure between glass plates and continuing environmental air pressure on the external surfaces that push them to each other. Therefore, the required force to separate of two connected planar glass is over than multiplying the atmospheric pressure with connected area of glass surface due to two external surface pressed by air [1].

C. Electromagnetic waves and capillary space

Capillary space effects molecular vibrations and electromagnetic waves. Helical oscillation of a string is polarized between narrow interspaces of parallel plates by loosing vibrations perpendicular to surfaces of plates. Similar polarization is available for lights that vertical waves cannot pass through a horizontal and narrow slot of a barrier, and this slot will allow only the vertical component of wave to pass. Therefore, the horizontal waves perpendicular to surfaces or direction of slot are filtered.

Because of this polarization, the complex helical waves lost some component and turns into planar wave. These examples of polarizations including lights are observed and performed in the real capillary spaces. [1, 7, 8]

It is suggested for capillary electrophoresis that a surface charge exist only on the walls of the capillary, and the electro-osmotic flow profile is essential flat like a piston [9, 10]. Two parallel plates behave as a capacitor, and electromagnetic fields transmit and flux over this system, and those transmissions are not lossless [11, 12]. Electromagnetic interactions of metal couples, capillary spaces and surfaces are unusual, and working a grounded apparatus that connected to ground by a conductor wire operates and protects the physical features of a medium [1].

D. *Biological system and capillarity*

Capillarity is one of the causes of the upward flow of water in the plants, and it does not spend energy as seen in active transport [13, 14]. Avascular heart of frog that myocardium devoid of coronary vasculature and blood circulates in myocardial sponge capillary bed that filled by blood at the short diastolic phase in spite of dilatation of myocardium and period of decreased blood pressure in ventricles [15].

Average of the total cross-sectional area of the systemic vessels is 2900 cm^2 and the biggest part of it, is capillary that 2500 cm^2 for human body. The pressure in the aorta is high, averaging approximately 100 mm Hg, but in a capillary vessel, it is only about 17 mm Hg [16, 17]. Relationships and reciprocal stoichiometric interactions of vessel diameter with blood temperature, blood viscosity, blood flow rate, blood flow velocity, blood pressure and hematocrit is reported as a circulatory control system analysis [18, 19]. The mechanical equivalent of heat for kinetic energy and pressure of blood flow is reported that high speed (sometimes turbulent) blood flow enters to the capillary vessels, and the energy of blood flow turns into heat by frictions (collisions), and therefore, pressure of blood flow decreases approximately up to zero at the vena cava and the entrance of the right atrium [20].

E. *Gravity*

The Cavendish experiment done in 1797- 98 by Henry Cavendish was the first to measure the force of gravity between masses, and the first to yield accurate values for gravitational constant and the mass of the Earth. When two massive lead spheres were brought as close as to two small balls, the gravitational forces of attraction made the suspended system turn slightly to a new position of equilibrium. In 1687, Newton presented his law of universal gravitation, according to which every massive body attract the other body by a force F given by;

$$F=Gm_1 \times m_2 /r^2,$$

where m_1, m_2 are the masses of two objects, r is the distance between their centre of mass, and G is the gravitational constant [21].

In a modern laboratory apparatus, the Cavendish balance is basically the same as the original. However, results of these experiments are formulated by distance between centers of masses, but the real width of the narrow (as close as) spaces between surfaces of the masses were not evaluated. Very seldom studies were done in vacuum without sufficient comparison. Most of the studies discussed the sources of errors like as convection, temperature, oscillation, torsion resistance, and altitude. In addition to factors having effect on dynamics, the electromagnetic field of connected masses is higher at the surface of the small sphere than the big one, and if two spherical mass connected by a conductive wire, they polarized as positive and negative that attached to each other [22 - 24].

II. Methods

A sensitive electronic scale (Precisa XB 220A, Made in Switzerland, e=0.001g, d=0.0001g), stage of a clinical microscope that vertically mobile on the body accepted as a micrometer and carrier of glass objects with sensitive motions of fine adjustment switches, a cup of distillate water (201 000 mg), smooth glass plates (2 x 125 x 57 mm, and 37 502 mg) and a glass cube (133 x 125 x 57 mm, and 250 988 mg) were used. Weights of objects are observed as given above that all digits are represented with level of milligram on the scale screen. Bottom and upper surfaces of these glass objects were equal and rectangular (125 x 57 mm). The reasons of choosing glass materials were the real smooth surfaces that essential to make a detectable capillary space, and inertia in electromagnetic fields.

During the whole periods of the experiment; the stage of the microscope, pan of the scale and surface of glass plates were kept in parallel positions to the surface of water. The glass plate and then the glass cube were attached to the stage of the microscope by a vertical wooden pipe one by one, and the wooden pipe is free from thermal expansion and magnetic fields. Nasal mask and cotton gloves were used to avoid heat transfer to the apparatus from the body of researcher. Body of scale and microscope connected to the ground by thin cupper wires to avoid the effects of electromagnetic accumulation and static electrical charge. The electronic scale is free from iron and effects of magnetic fields. The weight of one glass plate and later the water was measured on the scale separately. Remaining glass plate and afterward the glass cube was mobilized vertically with the stage of the microscope to constitute a narrowing capillary interspaces on the upper surface of the weighing mass. Therefore, during the separate capillary interactions between mobile objects (on the stage of the microscope) and the stable objects on the scale; the four set of experimental weighing process (the glass plate by the glass plate; the glass plate by the glass cube; the glass plate by the water; and the glass cube by the water) were done.

While measuring the weight of a stable object, the capillary width between the stable and the mobile object was decreasing to the minimal narrow space (less than 0.5 mm) by slow motion of two rotary switches of the stage. Between every step of minimal motion of stage of the microscope, one minute of motionless period was given to control of fluctuation and balance of the scale.

While narrowing the capillary space, measured minimal stable weight of the object was recorded as a result that just before connection. These periods of measurements were controlled very carefully to avoid of any complication of connection between objects. These complicated results of measurements that exhibited an acute change of weight or fluctuation of scale cursor due to connection were excluded.

Every set of experiment was repeated numbers of times to obtaining experience for sensitively manipulate the stage of the microscope by minimal motion of switch. When the measured minimal weights become stable at least twelve times consecutively, these amounts of weights were collected as correct results. Laboratory temperature and other conditions were kept stable, and whole apparatus were avoided from airflow or direct sunlight during the measurements.

III. RESULTS

When the width of capillary interspaces between stable surface on scale and mobile surface on the stage of microscope was narrowing to (approximately) less than 1mm, the monitored weight was starting to decrease, and later reaching a minimal value of weight just before connection of two surfaces. During five minutes of motionless pause at the capillary width (0.5 mm), the decreased weights were clearly stable without any fluctuations, and later adjustment of the capillary space produced the same weights at the known width by back and forth motions of the switches. Later then reaching the minimal weight at the narrowest capillary width, to collect a more little weight was becoming very difficult that the minimal motion of the stage was producing a connection between two surfaces. According to all of the observations, there was a negative relationship between capillary width and decreasing weight (force of capillary collapse) of the mass. However, the exact mathematical relationships between force and width (linear or inversely related to square of capillary distance) could not determine by these apparatus and condition of the laboratory. Thinking the decreasing weight like force of attraction should be dependent on the surface area of capillary interaction, decreasing weight per unit area was defined as:

Decreasing weight (like attraction force) per unit area = decreasing weight / area of capillary interaction surface.

Weight of the stable glass was decreased 10 mg exactly. The decreasing weight per unit area = 1.40 mg/cm^2 [(125x57=7.12 cm^2); (10 / 7.12=1.40 mg/cm^2)]. After that, when the mobile glass was taken back to a long (over than 1 mm) distance from the stable object, the weight of the stable object returned to the normal first value without any fluctuation of the values. When the mobile glass plate (attached to stage of the microscope) was displaced by the heavy glass cube that surfaces of them were equal, the results of measurements (decreasing weight= 10 mg) were the same (stable). Maximal amount of decrease for observed weight of water was 8 mg by narrowing capillary distance, and the decreasing weight like force of attraction per unit area = 1.12 mg/cm^2 (8 / 7.12=1.12 mg/cm^2).

When the distance returned to the long (over than 1 mm) distance between surfaces, observed weight of water returned to the normal first value. Displacement of glass plate by the heavy glass cube did not change the result that decreasing weight of water was the same (8 mg); the capillary interaction surfaces were the same 7.12 cm^2 for all experiments. When a minimal contact appeared between surface of the water and the surface of the mobile object, the nearby surface of water upraised on the border of glass plate, and the weight of water was decreased a 175 (+/-3) mg suddenly. The force of attraction per unit area was 175/7.12 = 24.57mg/cm^2. There was not a contamination (residue) of water on the surfaces of glass at the end of this step of experiment. In addition, after removing the mobile object to a long (over than 1 mm) distance; the weight of water returned to the normal first value. However, when the mobile glass was immersing into the water, the observed weight of water was increasing on the scale. According to the aim, the subject and the method of the study (capillary distance), complicated results of the experiments with connection of glass surfaces by water were excluded from the study.

IV. DISCUSSION

A. *Concept of capillary collapse*

According to information given in the introduction, capillary space could changes the features of some physical process. Result of this study suggests that when two objects have planar surfaces and approached (close) to each other up to capillary distance (approximately less than 1 mm) by parallel position of their surfaces, a factor appeared like as force of attraction, and it is detectable via decreasing weight of the objects on the scale. In fact, the nature of this weight decreasing effect originated narrowing capillary space is unknown at this step of the study. It could be only decreasing air pressure (force) on the weighing object with capillary effect. However, long and stable period of decreased weight on the scale must be explained by stoichiometric and mathematical relationships of variables of the experiments. Therefore, up to collecting clear evident for nature of this weight decreasing effect, temporarily using term of “force” may be useful for mathematical process that factors like pressure, area of surface, decreasing weights like force must be prepared in one equation for evaluate of this experiment. On the other hand, if it is not a new force, it must be a force decreasing effect on factors of this experiment. This force measured during capillary interaction between two surfaces like as attraction was very big than the gravitational attraction, and little than the force originating from atmospheric pressure. When the areas of capillary surfaces of two glass objects were equal to each other for the capillary interaction, the amounts of the decreasing weights were the same in spite of increasing weight of mobile mass (glass cube) on the stage. However, decreasing amount of weight is related by distance. In addition, when the experiment done between the same glass surface and water surface, the changing weight was related to the distance, but affected by chemical composition of weighing mass. While long experimental periods of open capillary space, the stable state of decreased weights of objects are additional proofs that there is a newly diagnosed condition or a factor in here and it deserves a new name and it could be "capillary collapse". By the way, the width of capillary space is suitable for increased effects of gravitational attraction, and compatible by the direction of gravitational force produces collapse of mass [25]. It could be concluded that declining of the mass into the centre is a common feature for these two fact ors, and the capillary collapse must be complicated by gravitation, and the gravitation experiment (implicated with very close two spheres) of Cavendish could be complicated by factor of capillary collapse.

B. Base of capillary collapse

Information and the results of the experiments given above could not prove a reason for decreasing weight of objects in relation to the decreasing amplitude of the capillary width. There is a famous example that when a ball enters into a narrow tube by big amplitude of vibrations; it is entrapped and continues to vibrate with increased frequency but little amplitude for a short time. Decreased amount of the kinetic energy of the ball is turned into the heat and sound via increased frequency of collisions between the ball and surface of the tube. Therefore, reason of capillary collapse could be concluded that the pressure and kinetic energy of gas molecules were decreased concomitantly in the capillary medium. One of the mechanisms could be decreased (extinguished) kinetic energy of air molecules via increased collisions between narrow capillary surfaces and gas molecules that kinetic energy of molecules converted into heat and then radiated or transferred to the periphery by mass of surfaces. This kind of process is called as isothermal reactions [1].

On the other hand, when an amount of air molecules are exhausted from capillary space by collision (pressure) of capillary surfaces, the air pressure of interspaces decreased, and this is an reasonable event. However, why free environmental air molecules did not refill this open capillary space, and why the decreased weights were stable during the long and motionless pauses of measurements? In addition, the decreasing weights per unit area of the objects are very little than atmospheric pressure (76 cm Hg=1033.6 gr/cm^2).

According to collision dynamics and the theory of probability, a speculative evaluation could be performed that while narrowing the capillary space, an amount of gas molecules could be exhausted by collisions out of the capillary, and it is presumable that exhausting is easy, but entering back to the narrow capillary orifice (split) between two surfaces is difficult and less probable for randomly mobile air molecules. When motions of air molecules are represented by vectors, it could be proposed that parallel orientation of direction (vectors) of moving air molecules to the surfaces of capillary space is very less probable, and therefore, molecules could not enter in the narrow orifice of the capillary space. In addition, reaching of the air molecules into the deep space of the capillary medium must be more difficult due to increased collisions with inner two surfaces of capillary. Collisions between air molecules and capillary surfaces could be result in decreasing kinetic energy of molecules due to conversion of kinetic energy into heat by collisions on the surfaces that result in decreased air pressure in the capillary space.

According to these evaluations, this capillary action like attraction force must be greater between big capillary surfaces for per square meter. Using mathematical and stoichiometric evaluation suggests that increasing length of side (line of capillary split) decreases the ratio of "area cm^2/sum of side cm" for a square, and making a sample calculation is easy that the ratio is 0.5 for square of2x2cm (length of sides), and 2.5 for square of 10x10 cm. If these approaches are true, capillary systems decreases the kinetic energy (and pressure) of air molecules, and then capillary space collapses.

C. Chemical Composition and Capillarity

In spite of equal areas of (7.12 cm^2) surfaces for capillary interaction, the difference of force of capillary collapse between glass by glass couple and glass by water couple could be explained by vapor of water surface. At the study of gravity, it is interesting that the result of Cavendish experiment depends on the chemical composition and internal structure of the test apparatus [12]. Thus, collapse phenomenon could be affected by gravitation and chemical compositions of mass at the capillary medium.

While little connection of two surfaces, closed surface of water by a mobile glass plate (attached on the stage) could be resulted in decreasing atmospheric pressure on surface of water. In addition, uprising a narrow line of surface of the water on the border of glass plate must be evaluated as a factor. The increased weight of water by immersed mobile object could be explained by principle of Archimedes that "such a body experiences an upward force equal to the weight of the fluid that would fill the space occupied by the immersed part of the body."

D. Increased Mass and Capillary Collapse

Changing (Increasing amount) of the mass (from the glass plate to the glass cube) did not change the decreasing amount of the weight on the scale while capillary interaction. These are conflicts to force of gravitation, or presumably the sensitivity of scale or increasing amount of mass of mobile object was insufficient. However, according to the results and limitations of the study, the capillary collapse must be related to distance between plates, area of surface and chemical composition of mass.

E. Biological functions of the capillarity

If the concept of capillary collapse (Decreasing amplitude of motion in capillary space) is true for every capillary space; it could be expected that the capillary vessels entraps the turbulent, vibrant or chaotic flow of blood, and capillary vessel decreases the pulsatile (amplitude of pulsation) properties of blood flow that originated from contraction of myocardium. Whole biological cells and their cytoplasmic tubular systems fall within capillary dimensions and they placed in some capillary constructions. Therefore, it could be proposed that mass transfer and chemical events of cells are affected by capillary features of the medium. Hematopoietic bone marrow is a gelatinous material interspersed within narrow trabecular bones formed by lamellar bone sheets and constitutes spongy capillary spaces that connected and opened to each other by capillary and sinusoidal blood circulations [26]. At the every step of running, all of the cells in bone marrow of femur are vertically pressed with over than 40 cm height of gelatinous mass by consecutive dashes. Compare that thrombocytes and erythrocytes are disrupted by a little shaking of a blood tube, and erythrocytes are destructed by centripetal gravitation of clinical centrifuge (r=9 cm) over than 3000/rpm [9, 26]. Thus, feature of the capillary construction could be evaluated as a protector system for the sensitive parenchyma of organs that absorbs vibrations, collisions and pulsatile pressure of blood. Compare that capillary porous fluid systems could be stored fluid without fluctuation, and may improve fuel transfer systems on future spacecraft safely. In addition, stored fuel (propane, hydrogen, or oxygen) in capillary porous system could not explode, fluctuate, resonate, or dash easily in empty space. The old lighters are safety for risk of explosions and leakage that explosive fuel stored in a capillary reservoir made by compressed cotton fiber.

F. The Cavendish experiment and capillarity

It is obvious that the forces of gravitation and the phenomenon of capillary collapse are complicated by each other in capillary space. Suppose that there are four equal mass, two of them are in spherical shapes and the others are smooth and equal two plates. When two spheres (radius is r=5 cm) are close to each other for experiment of Cavendish that distance between their surfaces is 0.5 mm, it is calculated that distance between centers of two mass is equal to 0.5 mm +2r=10.5 cm. However, when the distance between two surfaces of two plates is the same as 0.5 mm, and thickness of plates are equal to 1 mm, the distance between centers of masses of plates is equal to 1.5 mm (mass centre of plates is placed in middle distance of thickness that is 0.5 mm, and 0.5+2(0.5)=1.5 mm). According to equation of the gravitational force ($F=Gm_1 \times m_2 / r^2$), it is expected that gravitational force between two parallel planar mass is higher than gravitational force between two spheres, in spite of equal mass. Therefore, it could be concluded that shape of spheres produces minimum gravitational forces between two spheres. In addition, gravitation is focused in center, and increased collisions between particles produce spherical shapes. Probability of tangential collision between two spherical mass is more over than collisions between two spherical mass in centre-to-centre positions. Therefore, these statistical distributions of multiple collisions result in motion of rotation that mostly fates of kinetic energy should be turn into angular velocity via multiple tangential collisions. [27].

As a result, energy and mass distribution are related and determine to each other, and therefore, it could be expected that fate of free (kinetic) energy of air molecules is different in capillary space from free air space with increased collisions between air molecules and the capillary surfaces. Thus, new searches are required to collect very sensitive data based on a real time synchrony recorder for scale and micrometer, and correlation analysis among area of surfaces, width of capillary, force of capillary collapse and gravitation. Searching the effects of vacuum, darkness, stable temperature, increasing amount of masses, plate shapes in vacuum, and different area of surfaces with a regular gradient, and changing atmospheric pressure are required. Additionally, effects of different chemical feature of several mass (Glass, copper, iron or etc) and liquids must be searched. The more extended period (hours) of motionless weighing may yield different information. Whole apparatus of these experiments must be grounded by conductor wires, and working in an isolated laboratory like as Faradays cage must be tested.

V. Conclusion

Nature of capillary collapse must be separated from gravitation by further studies. The new concept and results of this study could increase the number of physical, chemical, and biological parameters. It should be considered in nanotechnology, mass and energy transfer in capillary spaces, and application or analysis of process at the capillary systems. This research and the manuscript is the first about the concept of capillary collapse that based on proven reality of the experiments and measurements. It is obvious that the air pressure is zero between connected planar glass plates. However, an initial point of distance for pressure decreasing process is unknown, and relationships of distance and pressure was obscure up to day. However, at least four important questions are subjects to further investigations to collect more information: Which forces, how, the longest period of persistence, and in which relationships? Controlling and directing of some physical and chemical reactions may be different in capillary space, and additional studies will lead to further advantages at the field of theory and practice.

REFERENCES

[1] J. B. Marion, W.F. Hornyak, General Physics with Bioscience Essay. New York: John Willey and Sons, 1985.

[2] N. Nevers, Fluid Mechanics for Chemical Engineers. New York: McGraw-Hill Inc, 1991.

[3] P.W. Atkins, Physical Chemistry. Tokyo; Oxford University Press, 1998.

[4] L. Ujejski, “The detection and separation of pectic substances by paper chromatography and paper electrophoresis,” The Ohio J Sci, vol. 57, July 1957, pp. 212-216.

[5] R.A. Wooding, H.J. Morel-Seytoux, “Multiphase fluid through porous media,” Ann Rev Fluid Mech, vol. 8, Jan. 1976, pp. 233-274.

[6] I.R. Kupke, B. Kather, S. Zeugner, “On the composition of capillary and venous blood serum,” Clin Chim Acta, vol.112, May 1981, pp. 177-185. doi:10.1016/0009-8981(81)90376-4.

[7] R.P.Feynman, R. B. Leighton, M. Sands. The Feynman Lecture on Physics. Massachusetts: Addison-Wesley Publishing Company 1965.

[8] I.G. Currie. Fundamental Mechanics of Fluids. New York: Marcel Dekker Inc, 2003.

[9] E. Epstein, R.E. Karcher. Tietz Textbook of Clinical Chemistry. Philadelphia: W.B. Saunders Company, 1999.

[10] G. Schomburg, H. Behlau, R. Dielman, F. Weeke, H. Husmann, “Sampling techniques in gas capillary chromatography,” J. Chromatogr A, Nov. 1977, vol.14, pp.87- 102. Doi:10.1016/S0021-9673(01)92028-x.

[11] D. K. Cheng. Field and Wave Electromagnetics. Ankara: Literatur yayincilik company,1994.

[12] L.B. Kruezer, “Experimental measurements of the equivalence of active and passive gravitational mass,” Phy Rev, vol. 169, May 1968, pp.1007-1012.

[13] S.B. Jones, “A capillary-driven root module for plant growth in microgravity,” Adv Space Res, vol. 22, June 1998, pp. 1407-1412.

[14] T.H. Riberio, R.W. Smith, J. Rubio, “Sorption of oils by the nonliving biomass of a Salvina sp.,” Environ Sci Technol, vol.34, May 2000, pp. 5201-5205.

[15] S.U. Sys, D. Pellegrino, R. Mazza, “Endocardial endothelium in avascular heart of the frog: morphology and role of nitric oxide,” J Exp Biol, vol. 200, Dec. 1997, pp. 3109-3118.

[16] A.C. Guyton, J.E. Hall. Textbook of Medical Physiology. Philadelphia: Elsevier Saunders Company, 2006.

[17] A.R. Choudhuri. The Physics of Fluids and Plasmas. Cambridge: Cambridge University Press, 1998.

[18] Y. Cinar, A.M. Senyol, K. Duman, “Blood Viscosity And Blood Pressure: Role Of Temperature and Hyperglycemia,” Am J Hypertens vol. 14, May 2001, pp. 433-438.

[19] Y. Cinar, G. Demir, M. Pac, A.B. Cinar, “Effect of hematocrit on blood pressure via hyperviscosity,” Am J Hypertens, vol. 121, July 1999, pp. 739-743.

[20] W.S. Topham, “Comparison of methods for calculation of left ventricular stroke volume,” J Appl Physiol, vol. 27, Nov. 1969, pp. 767-769.

[21] B.E. Clotfelter, “The Cavendish experiment as Cavendish knew it,” Am J Physics, Vol. 55, March 1987, pp. 210-213.

[22] G.I. Moore, F.D. Stacey, G.J. Tuck, “A balance for precise weighing in a disturbed environment,” J Phys E Sci Instrum, Vol. 21, June 1988, 534-539, doi:10.1088/0022-3735/21/6/002.

[23] J. Weber, “Evidence for discovery of gravitational radiation,” Physical Review Letters, Vol.22, June 1969, pp 1320-1324.

[24] R.V. Tevikian, “Gravitation and vacuum field,” Astrophysics, vol.23, March 1986, pp.590-594.

[25] U. Gerlach, “The equation of state at supranuclear densities and existence of a third family of superdence star,” Phys Rev, Vol. 172, Aug. 1968, pp.1325-1330.

[26] J.P. Greer, J. Foerster, G. Rodgers, F. Paraskevas, B. Glader, D.A. Arber, Wintrobe's Clinical Hematology. Philadelphia: Lippincott Williams and Wilkins, 2009.

[27] Y. Cinar, “Mass and kinetic energy distribution of the universe,” Proc. International Conference on Theoretical Physics. Birkhauser Verlag Press, Basel, July 2002, pp. 191-92.