28th
ORTVAY RUDOLF
PROBLEM SOLVING COMPETITION IN PHYSICS
1997

Deadline for solutions: **November 20 Thursday Noon, 1997.**,

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On FAX solutions can be sent to 36-1-266-2556 .

Any reference is allowed to consult. Each university year will be evaluated separately. For each problem 100 points can be given and no more than 10 problem solution will be evaluated. Participants are kindly asked to send each solution on a separate sheet, indicating their names and years. In case of (nearly) identical achievements preference will be given to contestants choosing problems appropriate to their year.

The jury will give out zero, one, or more first, second and third prize and further awards for each year.

For outstanding solutions of individual problems extra rewards can be given. Even with one solved problem prize may be won, therefore it is worth sending even relatively few solutions.

Declaration of results together with Physicists' Santa Claus will take place in the Eötvös Hall of building D, Science Faculty of Eötvös University, Budapest, on December 4, Friday 14.00, 1997. Contestants who solve the individual problems most successfully will kindly be asked to present their solutions after the declaration of results.
We wish instructive and successful problem solving for every contestant:

Board of Physics Students of Eötvös University

Hungarian Association of Physics Students

1. Oh, sunshine... Three people are standing in the middle of a field, somewhere on the perfectly spherical earth, facing the sun, basking in the sunshine. However, nothing lasts forever, even the sun moves in the sky. So, our sun-worshippers start following the sun in such a way that their velocity vectors always point in the opposite direction as their shadows. Arthur Accelerationless never gets tired, the magnitude of his velocity is constant. Bob Bottomheavy soon realizes that he would never catch up with the sun, loses his heart, and as his shadow grows longer, his velocity decreases inverse proportionally to the length of his shadow. On the other hand, Clement Catchup turns ever angrier and faster: his velocity is proportional to the length of his shadow.

   What paths are traced out by the three sun-worshippers (A,B,C) on earth?

   Discuss the solution according to the choice of starting point, the day and minute of their set-offs, their initial velocity, and (in the case of B and C) the coefficients of the velocity function. Examine the possible types of motion and final points. (For simplicity, suppose that even the deep blue sea cannot mean any problem for our wanderers.)

   (Barnaföldi Gergely – Dávid Gyula)

2. Thor would like to have fish soup for dinner, so he creates a fireball on the bottom of the lake. What will happen? A fireball is a region with an approximate diameter of 1 metre where suddenly (in approximately 1 second) such an amount of heat is produced that it would by far be enough for boiling and evaporation (if it were applied slowly) – however it is not enough for molecular ionisation.

   (Csilling Ákos)

3. Sommefeld's parity violating pocket knife
   If a pebble is placed on the table with its convex side down and is spinned in either direction, it will usually slow down smoothly and stop. Seldom, in case of pebbles with special shapes it may happen that a pebble spinning in one direction will start spinning in the other direction and stop only afterwards. Nowadays, we can see such special shaped plastic "pebbles" in some toy shops, and Sommerfeld's pocket knife is said to have been capable of this trick. Give a physical explanation to the phenomenon, and examine whether it is possible that a body spun on the table can turn back from BOTH directions.

   (Radnai Gyula)

4. How large can be a unicelled that can serve for dinner for another cell (a macrophag)? Macrophags are made up of approximately 60 per cent liquid and 40 per cent dry matter. Within the cell dry matter can only exist in the form of small spheres. The volume of one sphere must exceed 0.5 per cent of the total volume of the macrophag. Swallowing the unicelled happens by means of pseudopodiums. The surface of the pseudopodiums cannot be more than 5 per cent of the total surface.

(Horváth Anna)

5. (The following problem is connected to one of the problems of the 1997 Eötvös competition.)

   A string of beads on a flexible thread is placed in a glass standing on the brink of a table. If a part of this chain hangs out of the glass, it will start accelerating and will eventually pull the rest of the chain out of the glass. According to experiments, after a while the part of the chain falling over the rim of the glass will be lifted and turns over well above the rim. Examine the motion, the energy relations, the exerted forces, and explain the lifting of the chain.

(Gnädig Péter)

6. An effervescent tablet is dropped in water. Determine its size as a function of time.

(Horváth Anna)

7. Consider an inextensible chain in a uniform gravitational field suspended by both ends. Examine the propagation of small perturbations along the chain. Set up the wave equation in an easy-to-handle way, and derive the dispersion relation. Study the different excitation states and give approximately the corresponding angular frequencies. (The chain is excited only in the vertical plane of the rest curve.)

(Borsányi Szabolcs)

8. Estimate the seasonal change in the earth's angular velocity. What effects can this be attributed to? How could this fluctuation change in the past 100 million years? How large will it be in 100-200 years' time, after the advent of the greenhouse effect?

(Dávid Gyula)

9. Place three identical elastic balls along a straight line. Press the two outside ones together, in the direction of the axis, so that the one in the middle is compressed.

   a/ Examine the relation between the pressing force and the displacement.

   b/ Forcing a small displacement perpendicular to the axis on the middle ball, shearing can be introduced by the contacts. Describe the motion of the system. Special care should be taken of the boundary conditions at the contacts.

(Kertész János)

10. A rolled up water hose of radius R, length L and mass M is rolled out on a horizontal plane with an initial velocity v_0 in such a way that its end is fixed. The hose moves as a hoop with decreasing radius and mass but increasing velocity. (Losses due to friction and resistance of media and the effects of gravitation can be neglected, as $1/2Mv^2 \gg MgR$.) Use the system of units $M = 1, L = 1, v_0 = 1$. Calculate the mass of the hoop, its radius and velocity as a function of the covered distance x. Determine the external forces acting on the hoop. Show that

$$v = \frac{1}{\sqrt{1-x}}, \qquad F_x = \frac{1}{2(1-x)} \quad \text{and} \quad F_y = 0,$$

   where F_x and F_y are the force components parallel with, and perpendicular to the velocity.

   Study the conservation of angular momentum with respect to the fixed endpoint of the hose.

(Gnädig Péter)

11. Strong boys, after consuming enough beer, can easily fold tops of beer bottles by compressing them between their forefinger and thumb. Estimate the necessary force for such a feat of strength. (You may neglect the milling on the rim of the bottle-top, or even consider it as a flat disk.)

(Cserti József)

12. Before hearing is established, sound waves have to be transformed into chemical signals. How large are the increase and decrease in the intensity of sound waves within the internal ear, if the propagation path of the waves is air–membrane–bone–bone–bone–membrane–air? Where should the series be cut to avoid resonance? For the geometric arrangement consult some anatomical references. Mechanical properties can be approximated by regarding membrane as a rubber layer, and bone as scale.

(Horváth Anna)

13. Podunk's local government is going to set up a new attraction in the local amusement park, namely the Podunk's Swinging Lift (PSL). According to the plans the PSL would be differ from the ordinary lifts in the respect that:

  1/ there is, as the name suggests, no elevator shaft, so that the cabin can swing without restriction apart from just moving vertically.

  2/ there will be no engine in it therefore the ride would depend only on the tug–of–war between the swinging elevator cabin and the vertically moving counterbalance. (The vertical frame allows only one plane of movement for the cabin.)

  The problems began when all of the known lift making firms refused to develop a detailed technical design, so that the local government had to turn to wider range of prospective designers for completing the necessary basic calculations that would allow a safe operation of the system. The most important questions are the following:

  a/ How many passangers should fit into the cabin given mass of the counterbalance?

  b/ There is a pneumatic mechanism, that can be used to start and stop the lift and also to hold the cabin steady for boarding, mounted on the frame of the lift. This mechanism can be approached via stairs. The mechanism can only impart a certain (given) amount of horizontal momentum to the vertically situated cabin, by knocking it. What should be the range of the starting height for the point of view of the system's safety? (The length of the wire–rope is the same as the height of the frame.) How does the nature of the ride change as a function of the starting height?

  c/ What is the longest safe ride given that braking can be carried out only at the starting height?

  d/ During the round is it necessary to protect the passangers against bumping their heads? Can the cabin turn over?

  e/ Find the maximal safe value of tension in the wire-rope! Can the designers be sure that the rope is tense all the time during the ride?

  Besides the point of view of safety, economics also have to be taken into account: varied rounds would be needed which draw the attantion of many people. The smooth operation of the system would be guaranteed by one of the representative of the council who is a retired colonel running the local petrol station. The local government is grateful for every kind of result. Even partial results would be welcome!

(Kovács Zoltán)

14. During his breathing exercise, a yogi practises the floolwing mental technique: "During inhalation the body expands, during exhalation it contracts. Whenever I inhale, the surrounding air moves towards my nose, and whenever I exhale, it moves in the other direction.

  a/ Estimate the displacement of air at a given distance from the inhaling/exhaling yogi.

  b/ At what distance will it be immeasurably small?

  c/ How is the displacement influenced by the expansion of the body with inhalation and its contraction with exhalation?

(Márk Géza)

15. a/ One wants to take a shower, so opens the hot water tap. The hot water comes from a remote hot water reservoir through a fairly long pipe running in the wall. Noone has taken a shower recently, so the water in the tube has assumed the 10-degree surrounding temperature. What will the time dependence of the water temperature be if the water current is constant?

  b/ What happens if the wall (through which the pipe runs) has a nonuniform temperature distribution, i.e. on a short section the temperature is 0.001 °C instead of 10?

  c/ One lets the hot water run for a very long time (the hot water reservoir is supposed to be infinite). This, of course, makes the water too hot, so one opens the cold water tap (which will not be touched again). Then one starts playing with the hot water tap by turning it according to the following function of time: $\phi(t) = \phi_0 + \phi_1 \cdot \sin(\omega t)$. The quantity of the water flowing from the tap is proportional to the angular deflection. Find the time-dependence of the water flowing from the tap.

(Veres Gábor)

16. Derive the Neumann equation describing the time evolution of the area of a bubble in a two dimensional soap foam (i.e. several contacting bubbles):

$$\frac{dA_n}{dt} = f(A_n, n, k),$$

  where A_n is the surface of an n-faced bubble, n is the number of the faces, and k is the diffusion coefficient. Give the concrete form of the function f. What is the critical value of the number of sides?

(Daruka István)

17. A vessel contains liquid. The vessel is rotationally symmetric, but its wall is not perpendicular to its bottom. Determine the equilibrium surface of the liquid. (Consider only solutions with rotational symmetry).

(Farkas Zénó)

18. From the bottom of a water container placed on the table a tube leads to a cupboard sized black box next to the table. If some more water is poured in the container, the original water level decreases. On the other hand, if water is removed from it, the level will rise.

    What is inside the black box? Set up as simple a model as possible and give the change of the water level in terms of the water poured in or removed. Change the parameters of the model and determine the behaviour of the system.

(Csákány Antal)

19. According to Von Mises's condition, an isotropic material yields plastically if the stress is such that

$$\tilde{\sigma}_{ij}\tilde{\sigma}_{ij} > K^2,$$

    where $\tilde{\sigma}_{ij}$ is the traceless part of the stress tensor: $\tilde{\sigma}_{ij} = \sigma_{ij} - 1/3\sigma_{kk}\delta_{ij}$,, and K is a material constant.

    According to Tresca, the yield limit is determined by the eigenvalues of the stress tensor. The yielding condition can be expressed with the smallest and largest eigenvalues of the stress tensor as

$$|\sigma_{max} - \sigma_{min}| > K'$$

    where K' is a material constant.

    Show that in two dimensions the Tresca's and Von Mises's conditions give the same criterion. Find deformations through which it could be experimentally decided which condition is realized.

(Tichy Géza)

20. In a large vessel, far form the walls, a spherical cavity (bubble) of radius R_0 is created with vacuum inside. The external air pressure is p_0.

    a/ Describe the behaviour of the wall of the cavity.

    b/ Describe the motion of a light particle inside the cavity if its initial velocity is v_0, and it collides elastically with the wall.

    c/ How do the above change if the bubble is initially filled up with gas of pressure p_0, and the external pressure varies with time as $p = p_0 \cos(\omega t)$? What is the minimal size of the bubble? How does its temperature change?

(Csabai István)

21. When a cluster of grapes is washed, quite some water gets stuck in the inside, which can later be removed by careful shaking (without damaging the grapes, of course). How much water can stay in the inside (after shaking)? The cluster of grapes can be modelled by identical fixed spheres that fill out space as densely as possible, and we can neglect other parts of the cluster, e.g. a frame holding the grapes together.) On what conditions, and how much water can stay in the of this configuration? (The puddle of water is demanded to be connected.)

    Does the neglected frame has a role in case of real grapes? And the size of the grapes?

    Hint: Try to examine the phenomenon experimentally, too.

(Veres Gábor)

22. It is a oft-quoted thesis that conservation laws are consequences of symmetries. More specifically, in classical field theory for each continuous symmetry there exists a continuity equation for a conserved quantity. What symmetry implies the well known continuity equation of hydrodynamics?

(Dávid Gyula)

23. A one-dimensional rod of length L, Young modulus k, linear mass density $\mu(x)$ is rotated about its longitudinal axis with angular velocity ω. As it is well known, over a certain angular frequency $\omega > \omega_0$ the rod will "buckle", i.e. its equilibrium position will no longer be the straight line joining the two endpoints. Determine the aforementioned angular velocity ω_0.
    Hint: determine the Green function and take an inside look in the theory of integral equations.

(Hantz Péter)

24. Set up an experiment in which the propagation velocity of light between two points of space is not measured in a back-and-forth way but only in one direction. Or: show that this is impossible. Analyze the consequences of this problem on special relativity.

(Szabó László)

25. In relativistic hydrodynamics, in the presence of dissipative forces, the continuity equation is not satisfied by the (rest) density alone, but only by its sum with a vector perpendicular to the four-velocity. What can be its physical meaning? The continuity equation is usually considered as the mathematical form of the conservation of mass. Perhaps in our case this conservation law does not hold?

(Dávid Gyula)

26. In the era of Imre Madách (1823-64) the heat of the sun was believed to be produced by the carbon burning in its inside. From the mass of the sun and the outgoing heat it was calculated that the sun would be bright for another 5000 years. Give an estimate, how long the cooling of a real body with such mass and size would take after the energy producing processes are stopped.

(Veres Gábor)

27. A charge moves in an electrostatic field. The field is built up as a superposition of numerous random electic fields, generated by independent sources. Determine the probability that the lowest frequency of the light emitted by the charge is between ω and $\omega + d\omega$. Assume that the charge can only move in a plane.

(Pollner Péter)

28. Let $\mathbf{E}$ and $\mathbf{B}$ be static, electric and magnetic source-free fields in $\mathbb{R}^3$, respectively, which are infinitely many times differentiable. Furthermore, assume that they satisfy either of the following (Bogomolny) equations

$$\mathbf{E} = \pm\mathbf{B}.$$

Prove that as long as the equations describe a finite energy configuraion, $\mathbf{E} = 0$ and $\mathbf{B} = 0$.
Hint: Examine the twist of the fields in infinity.

(Etesi Gábor)

29. Calculate the partition function of classical perfect gas and a system of N independent plane rotators. Why is it necessary to use different normalizations in the two cases in order to get extensive potentials?

(Pollner Péter)

30. Gas is known to permeate all space available. Specifically: if half of a vessel is filled up with gas and the other half is empty, and the separating wall is removed, the gas molecules will soon fill up both halves of the vessel uniformly. Statistical mechanics explains this by arguing that the macro state in which both halves contain gas is realized by many more micro states than the asymmetric one, therefore it is much more probable.

However, according to quantum mechanics, particles are indistinguishable. So, the state in which only half of the vessel contains gas is only one quantum state, just like the other state when the vessel is uniformly filled out, as sheer interchange among the particles will not result in a new state. Therefore, the usual argument of statistical physics falls through. Still, despite quantum theory and Pauli's exclusion principle, our experiences show that gas after all permeates all space available. Why?

(Gnädig Péter)

31. The virial theorem of classical mechanics establishes a relation between the total energy and the time averages of the kinetic and potential energies for a system performing a bound motion. The relation is especially simple in case of potential energies that are power-law functions of distance (see Landau and Lifshitz, Theoretical Mechanics, Volume 1). In quantum mechanics, a similar formula holds, though not for the time average but for the expectation value, e.g in the case of a hydrogenic atom (see e.g. Constantinescu and Magyari, Quantum Mechanical Problems, problem 3/8). Examine the case of a dielectronic helium atom, where electric interactions are mediated by $n = -1$ power-law functions between each pair of particles. Does the virial theorem hold? What are the effects of the interchange interaction of typical quantum mechanics?

(Györgyi Géza – Dávid Gyula)

32. Model the motion of a fleeing space-fly. The latest problems of Space Station MIR have been caused by a fly. This gives the astronauts a serious headache, as the fly disturbes their work. They ask for the help of the Ortvay competitors. According to video records, the motion of the fly has the following features: in the state of weightlessness the fly cannot percieve any preferred direction (gravitational and magnetic fields do not affect its motion). For obvious reasons, the fly is in a state of panic, and so it flies with its final speed throughout its motion. The direction of its motion is determined by the processes happening in its mind − and they are as clear as mud. The only thing we know about them is that they are "clear as mud uniformly in time" (fly-psychology is not a fully developed science yet).

   a/ Describe the motion of the fly.

   b/ Characterize the flight path.

   c/ How could the walls be incorporated in the description of motion?

   d/ The astronauts get fed up with the insolent animal and decide to close it in a lock chamber (which is separated from the rest of the space ship by a narrow slit that can be opened and closed). In the instant $t = 0$ the fly was observed to be in the immediate vicinity of the lock chamber. According to the quantitative analysis of the motion they think that in certain instants of time the fly is more likely to be in the vicinity of the lock chamber. Can we determine these instants of time in our present model?

(Alács Péter)

33. There is a classical spin in each corner of a square. Assuming nearest neighbour interaction between them the Hamiltonian of the system is

$$H = \eta\, \mathbf{S}_1 \cdot \mathbf{S}_2 - \mathbf{S}_2 \cdot \mathbf{S}_3 - \mathbf{S}_3 \cdot \mathbf{S}_4 - \mathbf{S}_4 \cdot \mathbf{S}_1,$$

where $\eta \in [-1, \infty[$, and all spins are of unit length, i.e.

$$(\mathbf{S}_i)^2 = 1, \quad i = 1, \cdots, 4.$$

Determine the ground state of the system as a function of the parameter η. Calculate the energy and magnetization of the system in ground state.

(Cserti József)

34. A one dimensional system is described by the following Hamiltonian:

$$H(x,p) = x^2 p^2 - \frac{1}{x^2}.$$

Examine its classical and quantum behaviour, its motion, its energy eigenvalues, and its spectrum. Special care should be taken of the construction of the Hamiltonian operator.

(Bajnok Zoltán)

35. The method of partial waves describes the quantum mechanical problem of elastic scattering in a central potential field by means of the δ_l phase shifts that can be read off from the asymptotic form of individual partial waves (angular momentum eigenstates). Can such a scattering potential $V(r)$ exist (apart from the trivial, uniformly 0 potential) in which, on a fixed energy, each partial wave has 0 phase shift, i.e. the system is supertransparent?

(Dávid Gyula)

36. Determine the energy levels of the fullerene molecule (C_{60}) in tight-binding electron approximation. Assume in the model that atomic cores are located as if they were atoms of a fullerene molecule and *one* electron is added to this system. The Hamiltonian is

$$\hat{H}|i\rangle = \epsilon_0|i\rangle - t\sum_{j=0}^{60} \alpha_{ij}|j\rangle$$

where $|i\rangle$ designates the state in which the electron is coupled to the ith atom, and $\alpha_{ij} = 1$ if i and j designate neighbouring atoms, 0 otherwise. The problem should be solved by considering the symmetries of the molecule. What can we say about the degeneracy level of the individual energy levels? (The solution can be tested numerically).

(Farkas Zénó)

37. Consider the following decoherence model that tries to deduce the classical features of macroscopic bodies from quantum mechanics. A pointlike particle of mass M moves in one dimension and it collides with n particles (each of mass m) moving along the same line. Let $M \gg nm$ (e.g. gas atoms collide with a very massive particle - Brownian motion). The light particles do not interact among each other, and the interaction of the heavy particle and the light particles can be modelled by the rigid sphere potential. Let the initial wave function of the light particles be

$$\frac{1}{\sqrt[4]{2\pi\sigma^2}} \exp\left(-\frac{(x_j - x_j^0)^2}{4\sigma^2} + i\frac{p_j^0 x_j}{\hbar}\right),$$

where x_j^0, p_j^0, σ are constants, and x_j is the coordinate of the j-th particle. Let the initial wave function of the heavy particle be $\psi(x)$. Calculate the reduced density matrix $\rho(X, X')$ of the heavy particle (see Landau and Lifshitz, Theoretical Physics, Volume 3). Assume that the observable properties of the heavy particle are eigenstates of the reduced density matrix, that is they are described by the $\varphi_j(X)$ solutions of the eigenvalue problem

$$\int_{-\infty}^{\infty} dX' \rho(X, X') \varphi_j(X') = p_j \varphi_j(X).$$

Determine these functions and the probability of their occurence p_j, if

a/

$$\psi(X) = \alpha \frac{1}{\sqrt[4]{2\pi\sigma_0^2}} \exp\left(-\frac{(X+a)^2}{4\sigma_0^2}\right) + \beta \frac{1}{\sqrt[4]{2\pi\sigma_0^2}} \exp\left(-\frac{(X-a)^2}{4\sigma_0^2}\right),$$

where $\alpha \neq \beta$ and $\sigma_0 << \frac{\sigma}{\sqrt{n}} << a$, i.e. $\psi(X)$ is the superposition of two distant narrow Gaussian functions.

b/

$$\psi(X) = \frac{1}{\sqrt[4]{2\pi\sigma_0^2}} \exp\left(-\frac{X^2}{4\sigma_0^2}\right),$$

where $\sigma_0 >> \sigma$, i.e. $\psi(X)$ is one wide Gaussian function.

Calculate the functions φ_j in momentum representation, too. Are the physical consequences derivable from the model in accordance with experience?

(Bene Gyula)

38. The conductance of a clean nano-wire at low temperatures is quantized. Suppose, we have an infinitely long straight wire. Then the conductance is given as

$$G = \frac{2e^2}{h} N,$$

where e is the electron charge, h is Planck's constant and N is the number of open modes in the wire at Fermi energy E_F. Open modes are the propagating wave solutions of the Schrödinger equation in the wire at energy E_F such that

$$\psi(x, y, z, E_F) = \Phi_{n,m}(x, y) e^{ik_{n,m} z},$$

where z is the coordinate parallel to the wire and x and y are orthogonal and the wavenumber $k_{n,m}$ is a real value depending on the n, m quantum numbers. The wave function $\psi(x, y, z, E_F)$ vanishes outside and at the wall of the wire. Calculate the conductance as a function of the Fermi energy if the cross section of the wire is a circle or a square. The interaction between the electrons are taken into account by an effective mass, so that the electrons can be treated as the free electrons.

(Vattay Gábor, Cserti József)

39. Consider a two-dimensional quantum mechanical system whose potential is of the form $V(x, y) = \alpha y^2$, where x and y are the two planar coordinates. What is the conductivity of the system if the electrons are imagined to be let in at one end of the potential trough (i.e. $x = -\infty$) and the number of electrons arriving at the other end (i.e. $x = \infty$) is measured. In such a case we can try the wave function ansatz resulting as the product of a longitudinal (x-direction) wave and a transverse mode (y-direction): $e^{-ik_n x} \cdot u_n(y)$. One can say that the electron is in the rth channel if its transverse wave function is exactly $u_r(y)$. To obtain the solution make use of the Landauer formula establishing a relationship between the transmission amplitude (resulting from the transmission matrix elements t_{nm}) and the conductivity. (The quantities $|t_{nm}|^2$ give the scattering probability of an electron from the nth channel to the mth channel.)
English and Hungarian references available at the homepage *http://galahad.elte.hu/~gegix/publ.html* can be used.

(Szálka Gergely)

40. How large background would be detected in the Gran Sasso neutrino detector if a muon accelerator were built in the tunnel of LEP?

(Csilling Ákos)

41. As is well known, the equation of motion in Aristotelean mechanics... would have been, had Greeks been familiar with differential equations

$$\dot{\mathbf{r}}(t) = \mathbf{e}(\mathbf{r}, t),$$

where r is the radius vector of the particle, and the function $\mathbf{e}(\mathbf{r}, t)$ is the so-called *hypoforce* which describes the effects of the particle's neighbourhood. In the absence of such a hypoforce the solution of the equation is $\mathbf{r} = const.$, i.e. the natural state of bodies is equilibrium. Ever since Galilei, Newton's law is valid:

$$\ddot{\mathbf{r}}(t) = \mathbf{f}(\mathbf{r}, \dot{\mathbf{r}}, t),$$

where $\mathbf{f}(\mathbf{r}, \dot{\mathbf{r}}, t)$ is the ordinary *force*; since then force-free state corresponds to uniform, rectilinear motion.

At the breaking of the 21st century, a new revolution is taking place. N.G. Neer and J. Berwocky (researchers of the University of Santa Claus) have recently published [X Files, **42** (1997) p. 137.] the so-called Newerton law:

$$\dddot{\mathbf{r}}(t) = \mathbf{F}(\mathbf{r}, \dot{\mathbf{r}}, \ddot{\mathbf{r}}, t)$$

where $\mathbf{F}(\mathbf{r}, \dot{\mathbf{r}}, \ddot{\mathbf{r}}, t)$ is the so-called *hyperforce*, which describes the effects of the particle's neighbourhood. Examine the consequences of the equation. Derive the analogues of the well known conservation laws. Determine some simple solutions, i.e. in case of some specific hyperforce function choices (hints: free motion, free fall, harmonic oscillator, hydrogenic atom). How does the derivation of the inertial forces appearing in accelerated reference frames change in the mechanics of the new age? Interpret the inertial hyperforces. Try to work out the new versions of Lagrangian and Hamiltonian formulations; set up the Hamilton-Jacobi-Neer equation and the Poisson-Berwocky brackets. Make the first steps towards the extension of the new mechanics into special (hyper)relativistic and quantum theoretical directions. Those who know the ropes can set up a hyper-Schrödinger equation (and can even solve it)...

(Dávid Gyula)

42. Camp for Freshmen... N boys studying physics and N girls studying *liberal* arts are sitting by the flickering campfire. Just by them are N, strictly coed tents (for two people each). Egon Quark has to arrange the sleeping order.

It is known that on the average each person is willing to sleep in one tent with m members of the other sex - but only Egon knows who with who. How should $m(N)$ be chosen so that Egon would have a 50% chance to arrange a sleeping order that is satisfying for everyone? Give the asymptotic behaviour of $m(N)$ as $N \to \infty$.
For N fixed, define the width of the transition "Egon flunks $-$ Egon does not flunk" ($f(N)$). How does $f(N)$ behave as $N \to \infty$?

(Piróth Attila)

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