cuts in the size of enlarging graduate classes were made. Certainly the seriousness of the employment plight was not realized in 1966, and this would have had to have been the case if the caption for figure 3 were to be accurate. In fact, from the data of figure 3, it can be seen that the total increase in PhD production of the "leading" 30 departments is about the same as that of the remaining 120 departments combined. The figure on page 63 of the same issue also indicates that the caption we refer to above is incorrect. Students have not simply gone to lower-ranked institutions, but there has been an overall drop in physics enrollment as illustrated by the figure on page 63 and the 1971 annual report of the American Institute of Physics.

We hope that Bromley and the other members of the Physics Survey Committee will review the attached graph, which plots their data on a linear scale and will perhaps revise their viewpoint on patterns of PhD production in the United States over the last few years.

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Magic cosmic numbers

Referring to the article "Cosmic Numbers" by Edward R. Harrison (December 1972, page 30), we would like to call your attention to a few more coincidences that may help understanding of some magic in the list of magic numbers. Abdus Salam has proposed the idea of *strong gravity* in order to introduce a natural cutoff in hadron physics. What we consider worth mentioning are coincidences associated with the coupling constant of *strong gravity*. Let us take four different lengths: the Planck length $1 = (\hbar G/c^3)^{1/2}$, the Schwarzschild radius $a = 2Gm/c^2$, the gravitational Bohr radius $r = \hbar^2/(Gm^3)$ and the Compton wavelength $\lambda = \hbar/(mc)$. These lengths are made up of three of four basic quantities $\hbar$, c, G and m. Now notice that the magnitudes of all four, evaluated for a nucleon, fall in the order of the nucleon size if one replaces the Newtonian gravitational constant G by the *strong* constant $G' = NG$. Here N is equal to N_1'' of Harrison's article: $N = \hbar c/(Gm_N^2) = 1.6 \times 10^{38}$, which corresponds to the ratio of the strength of nuclear forces to gravitational forces. This magic is however not all surprising insofar as the replacement of G by G' is legitimate. With the present choice of N the nucleon mass is identical to the Planck mass defined with G': $m_N = (hc/G')^{1/2} = m_P'$. Hence all the lengths defined above with G' reduce upon elimination of G' to the nucleon Compton wavelength: $l' = (\frac{1}{2})a' = r' = \lambda_N$. The very trick of the magic must therefore lie in the seemingly active function of strong gravity in the small dimensions. Both kinds of the Planck length and mass are related by $l' = \lambda_N = N^{1/2}l$ and $m_P' = m_N = N^{-1/2}m_P$.

Harrison has the formula $R = [3c^2/(8\pi G\rho)]^{1/2}$ for the radius of a closed universe in its maximum expansion and suggests adopting the radius as a cosmic yardstick. It is interesting that the same formula with the nucleon density predicts the size of neutron stars. We would also like to point out that the replacement of G by G' again works for deriving $R_S/R_N = N^{1/2}$. For $m \approx 4\pi\rho R^3/3$, there follows the relation $R \approx Gm/c^2$, which Eddington used for estimating the radius of the universe. This relation has been tested for the Planck mass with G and for the nucleons with G'. It is reasonable for neutron stars as well. We wonder if Eddington's conjecture would be part of the grand rule underlying in the cosmic hierarchy.

Finally we observe that the normal gravitational Bohr radius of nucleons becomes roughly the size of the universe, while the strong Bohr radius coincides with the nucleon Compton wave length. This coincidence may be simply accidental. If, however, it is significant, the cosmic number $N_2 = R_U/R_N$ must be identical to N. Introducing the angular momentum $J = mRc$, we derive with Eddington's relation the following expressions: $m = (Jc/G)^{1/2}$ and $R = J^2/(Gm^3)$, which correspond to the Planck mass and the Bohr radius, respectively. The last coincidence could then be a consequence of another grand rule of quantization: $J = N^n\hbar$ ($n = 0$ for nucleons, $n = 2$ for neutron stars, $n = 5/2$ for galaxies and $n = 3$ for the universe).

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In his article Harrison points out that the number $N \approx 10^{40}$ can be obtained in several different ways. He concludes that, since we do not know how to "bootstrap" together microscopic and macroscopic realms of physics, "Each of us according to his own inclination is therefore free either to dismiss the coincidence as fortuitous, or to think that the coincidence is evidence of an underlying grand design in the structure of the physical world."

I would like to point out that this number emerges quite naturally in my

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letters

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fundamental theory of physics,[1] as a necessary relation between the radius of the universe ρ_0 the Compton wavelength of the proton λ_0 and the total number of protons in the Universe n_0, such that

$$\rho_0/2\pi\lambda_0 = (n_0)^{1/2} \approx 10^{40}$$

The theory starts with a set of dimensionless linear wave equations of the n_0 identical elementary particles in the $4n_0$−dimensional representation space of the closed universe. These equations do not allow any adjustable constant except n_0. The meaning of the equations is that the n_0 elementary particles are hypothesized to be built out of waves traveling at the speed of light. For the wave function to be stationary[1] it becomes necessary that the fundamental frequency of each particle is n_0. With a wave speed of unity, the wave length $2\pi\lambda_0 = 1/n_0$. The radius of the three-dimensional universe is $\rho_0 = 1/(n_0)^{1/2}$, and this yields the relation given above. It is a reasonable assumption to identify the elementary particle of our theory with the proton, or hydrogen atom, because all stable systems of the theory have a rest mass close to a whole multiple of the elementary particle, as all stable systems in the real world (atoms, molecules) are close to a whole multiple of the proton.

It is noteworthy that the wave equations of the theory are made dimensionless by writing $t(d/dt)$ instead of (d/dt), and that this leads to a beginning of time, and a size of the universe, which oscillates, $\rho_0 = t^1$, at a speed of the order of the speed of light.

Reference

1. P. J. van Heerden, "The Foundation of Physics," Wistick, Wassenaar, Netherlands (1967), page 85.

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More on Levich

It is impossible not to sympathize with Benjamin Levich (March, page 9) and his Soviet colleagues but, at the same time, I am totally dismayed by the shortsightedness displayed by them and their Western supporters. All the concern and emphasis is on Soviet oppression of Jews and "intellectuals" of various types. These are just the most evident victims of Soviet policy and to dwell on the particulars is to ignore and evade the fundamental issue.

Levich *almost* touches on this issue in his letter when he asks: "Are scientists free human beings? Or are they the property of the government?"