LETTERS *(continued from page 15)*

if one uses the tools of statistical physics, which have been applied to a gamut of subfields ranging from magnetism to earthquakes, one can formulate a theory of options that is clearer and uses a simpler mathematical formalism that allows for large deviations and crashes in particular.

We have attempted such an approach.[1] We think it could lead to a better understanding of the nature of the problems by both players in the market and managers of financial institutions. One critical aspect of our approach is that it calculates the risks associated with derivatives. As the record over the past 20 years shows, actual risks can be significant.

It is also evident that the lack of regulation has played a key role in the present turmoil surrounding derivatives. We believe that effective regulation will appear spontaneously when reliable quantitative estimates of the degree of risk of each market position can be developed. On this issue, we rely on the optimistic concept that the availability of useful information will lead to a natural limitation on exposure to risk. Recent work on complex systems has shown that feedback provided by the learning process is sufficient to create self-organized and self-regulated dynamical functioning, at least in biological systems (as discussed in PHYSICS TODAY, March 1991, page 9 and July 1991, page 9).

Much work remains to be done, both theoretically and practically, to bring about the efficient use of such risk estimators in the field of derivatives, as well as their application to other financial products.[2] Meanwhile, it is important to recognize that the financial world continues somehow to avoid the systematic use of risk assessments, even though they have long been applied to various industrial and natural hazards, such as the siting of nuclear plants and the occurrence of earthquakes.

References

1. J.-P. Bouchaud, D. Sornette, J. Phys. I (France) **4**, 863–81 (1994); J. Phys. I (France) **5**, 219–20 (1995). J.-P. Bouchaud, G. Iori, D. Sornette, RISK (March 1996).
2. J.-P. Bouchaud, D. Sornette, C. Walter, J.-P. Aguilar, J. Math. Fin. (1996), in press.

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Celestial Rays Raise Hopes of Finding Their Sources

Ultrahigh-energy cosmic rays, above 10^{19} electron volts, have been reported coming from the supergalactic plane (PHYSICS TODAY, December 1995, page 9). This result may be even more important than it first seems because it is supported by recent gamma-ray and x-ray observations. The gamma-ray observations up to about 1000 MeV from EGRET show extensions of this high-energy radiation down through the spine of the Virgo cluster of galaxies, and through the southern extension of that cluster and beyond.[1] The ROSAT x-ray observations show > 0.4-keV x rays coming from the Virgo cluster along this line.[2] They also show higher-energy (>1.0 keV) x rays extending farther south along the supergalactic equator for a total of over 11 degrees.[3]

The investigators who have made the cosmic-ray observations suggest that the rays are powered by active extragalactic objects situated in the Local Supercluster. This seems to be the only reasonable site for their origin and agrees with the suggestions that have been made for a similar origin for the observed gamma rays and x rays.

The possibility for making further important progress, of course, lies in the identification of the specific objects that are generating this huge energy and the elucidation of the basic physical mechanisms responsible.

References

1. H.-D. Radecke, Astron. and Astrophys., submitted (1995).
2. H. Böhringer, U. G. Briel, R. A. Schwarz, W. Voges, G. Hartner, J. Trümper, Nature **368**, 828 (1994).
3. H. Arp, Phys. Lett. A **203**, 161 (1995). H. Arp, in *Frontiers of Fundamental Physics*, M. Barone and F. Selleri, eds., Plenum, New York (1993), p. 1. See also news note in *Sky and Telescope* (January 1995).

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Lowest Notes on Violin Require Skill and Guts

The report (September 1995, page 20) of anomalously low frequency sound from the violin deals with what should really be called a rediscovery of a technique that has long been used by great violinists.

Despite the credibility of independent discoveries by Frederick Halgedahl and Mari Kimura, the credit for achieving low, nonharmonic tonalization through increased bow pressure has already been assigned to Niccolò Paganini. According to my source, virtuoso violinist Ruggiero Ricci, Paganini made use of this "secret" method to enhance his bow control—a practice later emulated by generations of virtuosos. Yet Paganini historian Joseph Gold believes that the actual discovery goes back to the great 18th-century violin master Giuseppe Tartini.

Although it is hard to discover anything new about the violin, the interpretations of Roger Hanson *et al.* and their mathematical underpinning by Knut Guettler are convincing and meritorious. They break welcome new ground in a field that tends to ignore how violins are actually played.

The forced subfundamental emissions are occasionally used to produce cellolike tones below the fundamental of the G string. But their musical significance lies primarily in their ubiquitous presence in sounds produced on the violin's other three strings under the dynamics of forte and fortissimo. The low musical third is an essential transient in each attack of the bow, and is especially audible in the staccato mode.

The technique of forced bowing required to produce low emissions is artistically acceptable only if old-fashioned gut-based strings are used. Metal and synthetic strings have frictional characteristics and stiffness that result in too much noise.

One amusing aspect of the recent interpretations is that they could have occurred 30 years ago if the members of the acoustics societies had been more inclined to generate sound from the violin as it is supposed to be done, by using the bow rather than mechanical transducers. Now, though, perhaps more acoustics scholars will rededicate themselves to the study of the real violin sound and will then be able to narrow the gap that exists between what they know and what performers feel.

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Cartoon Assessment

The cartoon reproduced on page 85 of the January issue is in exceedingly poor taste. Regardless of what view one takes in the current debate about the effects of electro-

magnetic fields, neither cancer nor capital punishment is an acceptable subject for attempts at humor.

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LHC May Be on Collision Course with Higgs Boson

The letter from Jay Orear (August 1995, page 15) casts doubt on the possibility that CERN's Large Hadron Collider could do Higgs particle physics, on the grounds that electroweak precision data would indicate a very high Higgs mass (on the order of 1 TeV). In a following letter, John Huth disputes this point of view, concluding that "the existing data on the top quark do not support the conclusion that the Higgs boson is very heavy and hence, at present, do not serve as a guide to the discovery potential of future accelerators."

Having been involved in precision tests of the electroweak theory for some time, we can provide a few pieces of information relevant to this issue. In particular, we argue that existing data disfavor, with increasing confidence, a Higgs mass of 1 TeV or more, and actually prefer a light Higgs, well within the LHC's reach.

Much of the information on the top quark and the Higgs boson masses comes from their virtual effects in electroweak processes as positron–electron annihilation (Large Electron–Positron and Stanford Linear Accelerator Center experiments) and neutrino scattering on electrons or nucleons. This information by itself constrains the masses of both the top quark and Higgs boson, although with a correlated uncertainty: As Orear says, the heavier the top, the heavier the Higgs, and vice versa. These indirect data favor a relatively light Higgs boson. The direct observations of the top quark in experiments at Fermilab by the Collider Detector Facility and the D0 group help to fix the top's mass with a relative error of less than 10 percent, thus reducing the above uncertainty substantially while maintaining a central value of the Higgs boson mass that is not very high.

In reference 1, we have combined the direct and indirect data together in a global analysis of all the available precision measurements known to date. We have done so within the framework of the minimal Standard Model of the electroweak interaction, but have made no other (restrictive) assumption.

In particular, our theoretical calculations of the electroweak radiative corrections include all first-order contributions, as well as the numerically relevant higher-order terms. For the Higgs boson mass, we have obtained a preferred value of about 80 GeV, with upper bounds of 220, 450 and 700 GeV at statistical significance levels of 68, 90 and 95 percent, respectively. We have concluded that the probability that the Higgs boson is heavier than 1 TeV is less than 2 percent. (Comparable results have been obtained by others independently.)

We believe that the results of our analysis are very promising for Higgs searches at the LHC. The precision of this type of estimate is likely to be strengthened as the top quark mass is measured with increasing precision at Fermilab, and as the W boson mass is measured better both there and at LEP 2. For the moment, all the indications are that the Higgs boson is well within the reach of the LHC.

Reference

1. J. Ellis, G. L. Fogli, E. Lisi, to appear in Zeit. Phys. C **69**, 627 (1996).

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Courage Bred at Oak Ridge Sets Example

In the "Letters" section of the October 1995 issue of PHYSICS TODAY, several writers discussed the topic of plutonium being bred in the biosphere that had been raised in the May 1995 issue by Alex Gabbard of Oak Ridge National Laboratory. They offered useful information and calculations, but the most important information presented was Gabbard's retraction of his original letter.

That was an act of courage that should be emulated by more scientists, particularly those in the federal agencies that are the most prolific in terms of pages published and for which there is no general forum for external peer commentary.

Zane Spiegel
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Quantum Mechanics Books Include Software

I'd like to correct an impression made in the review of the second edition of Brandt and Dahmen's volume *The Picture Book of Quantum Mechanics* (Springer-Verlag, 1995) that appeared in the January 1996 issue of PHYSICS TODAY (page 65). The reviewer aptly suggests that students would find it exciting to generate their own computer images of fundamental quantum processes (similar to the nearly 500 in this book), and he recommends that the next edition of the book be equipped with an interactive version of the software to facilitate this. The authors and publisher agree. They have been making the INTERQUANTA software and detailed instructions for its use available in *Quantum Mechanics on the PC* since 1989 and in *Quantum Mechanics on the Macintosh* since 1991. For an informative review of the Macintosh version, see the April 1992 issue of PHYSICS TODAY (page 87).

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Atoms on the Move—Up, Down and Acrostic

I thought that Noel and Stroud's experiment, as summarized in your "Physics Update" section under the heading "Interferometry within an Atom" (September 1995, page 9), would make an excellent journal club topic. I was so inspired that I was moved to compose this "Ode to a Rydberg Atom":

I never truly understood
How atoms oscillate,
Always turning back again
To their orig'nal state.
Eventually decaying,
Just as I felt they ought,
Only to coagulate
Until a packet's wrought.
Rydberg would be pleased to know,
'Neath his lonely grave,
Atoms of his namesake give
Life to Kepler waves.
Could I, too, a wavelet be,
Lasting momentarily,
Until I find myself once more
Beyond time's endless sea?

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Correction

February 1996, page 29—The frontispieces in figure 1 were reprinted with kind permission of Elsevier Science—NL, Sara Burgerhartstraat 25, 1055 KV Amsterdam, The Netherlands. ■