

LETTERS

tures as high as 125 K, laid claim to the title. . . . But in early May a group from ETH in Zurich reported measuring a superconducting transition temperature several degrees above 130 K in a compound containing mercury together with barium, calcium, copper and oxygen."

I suspect that the author missed our Rapid Communication in *Physical Review* this March.¹ We measured a T_c of 131 ± 0.5 K in $Tl_2Ba_2Ca_2Cu_3O_{10-x}$ —a value we believed to be the highest reported to date, as we stated in the abstract.

Reference

1. D. D. Berkeley, E. F. Skelton, N. E. Moulton, M. S. Osofsky, W. T. Lechter, V. M. Browning, D. H. Liebenberg, *Phys. Rev. B* **47**, 5524 (1993).

EARL F. SKELTON
Naval Research Laboratory
Washington, DC

7/93

Was Nuclear Collision Article Off Target?

In the article "Probing Dense Nuclear Matter in the Laboratory" (May 1993, page 34) Subal Das Gupta and Gary D. Westfall give one view of the recent history of nuclear collision transport models. For the record, I would like to present an alternative viewpoint and some corrections of basic facts.

The words "dense" and "hot" are often used in articles about nuclear collisions. Das Gupta and Westfall mention temperatures of "50–100 MeV" and densities of "3 to 4 times" the saturation density ρ_0 of nuclear matter as well as "2 to 3" ρ_0 . Readers should understand that any attempt to extract central densities and temperatures of nuclear collisions is extremely model dependent. The nuclear collision computer models (such as the BUU model, discussed by Das Gupta and Westfall) have a great many ingredients, some of which are neither very well understood theoretically nor treated consistently. For example, the nucleon–nucleon cross sections, mean field and momentum-dependent interactions should all be related consistently rather than being independent inputs to the computer code. Also, the quantum content of the BUU method is rather limited, being restricted to the phase-space Pauli blocking. Further, the ground state nuclei in the VUU–BUU code come apart¹ in times on the order of 100 fm/c. (This is better than in the old cascade model, but perhaps not good enough.)

The idea of "understanding the

nuclear equation of state" has been referred to by Das Gupta and Westfall as well as many others. Noting the absence of any definitive nontrivial knowledge about the phase diagram of nuclear matter, I wonder if one has honestly gained much understanding of the nuclear equation of state over the past decade. Certainly, the in-plane squeeze-out, out-of-plane squeeze-out and bounce-off effect are novel discoveries,² but so far these have only provided rather limited information about the nuclear equation of state.

Das Gupta and Westfall claim that an "incompressibility value of $K \approx 215$ MeV" has been obtained from heavy-ion collisions. Do they really believe we can extract K to a precision of ± 1 MeV? Others would disagree,³ finding in fact that the current complete data set is not adequate to limit the range of K to better than about a factor of 1.7 (200–350 MeV).

The BUU code referred to by Das Gupta and Westfall was developed by Jörg Aichelin and patterned after a code developed by Hans Kruse and coworkers. The code was first given the name VUU (Vlasov–Uehling–Uhlenbeck), in a paper that Westfall coauthored.⁴ Why do Das Gupta and Westfall also not mention the important theoretical work of C. Wong⁵ in the 1970s and early 1980s? Wong's ideas made the computational development of the VUU code a reality.

The complete absence of references to others⁶ in the international physics community who played a prominent role in a decade of nuclear transport equation simulations is striking. The computational work of George Bertsch, Das Gupta and Wolfgang Bauer was not done in a vacuum but rather in the context of work on similar ideas by many others.

The idea that the transverse momentum spectrum $p_x(y_p)$ (where y_p is rapidity in the direction parallel to the beam) rises from negative values at bombarding energies less than 100 MeV/nucleon to positive values at higher energies is clearly demonstrated in the context of the VUU model in reference 7, I believe for the first time.

Das Gupta and Westfall assert that "the number of pions produced is small" between 100 and 1000 MeV/nucleon; in fact the number of pions increases dramatically from low values below the threshold energy of a few hundred MeV/nucleon to substantial numbers at high energies. I assume that Das Gupta and Westfall are also aware that the flow angle is measured in degrees and not MeV/c per nucleon, as in their figure 3.

NEW . . . LOW COST

underwater light detectors

"SUD" SERIES (Different Types)

... for the measurement and detection of optical radiation underwater. A spectral range of 200nm to 1100nm can be monitored with choice of detectors. Pulse light integration speeds as fast as 6 Microseconds to steady state.

FEATURES:

- * Low Cost
- * Every unit is depth tested to 41 meters (135') and carries a one year warranty.
- * Rugged package construction utilizing 1/2" thick quartz optics.
- * 100' cable includes RF and EMI shielding.
- * Compatible with I.L. Radiometers and Photometers.
- * Can be used with optical filters for spectral studies.

APPLICATIONS:

- * Absorption studies.
- * Pollution detection.
- * Plant Growth studies.
- * Biological studies at air - ocean interface.
- * Underwater communications.
- * Bioluminescence.

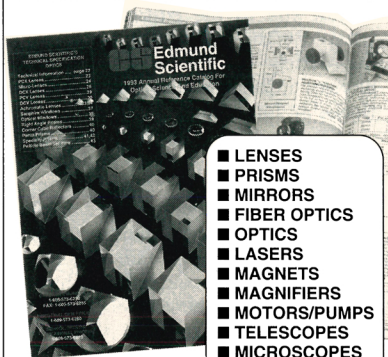


international light inc.

17 GRAF ROAD
NEWBURYPORT, MA 01950 U.S.A.
TEL. 508-465-5923
FAX 508-462-0759
TELEX 94-7135

Circle number 71 on Reader Service Card

Edmund Scientific



- LENSES
- PRISMS
- MIRRORS
- FIBER OPTICS
- OPTICS
- LASERS
- MAGNETS
- MAGNIFIERS
- MOTORS/PUMPS
- TELESCOPES
- MICROSCOPES
- POSITIONING EQUIPMENT
- COMPARATORS
- EYEPIECES

FREE

Reference Catalog For Your Technical Library

220 Pages, Over 8000 Products

Our new, full color catalog describes one of the largest and most diversified lines in the nation of precision lenses, optics and optical instruments plus many hard-to-find scientific and technical products used in science, industry and by researchers.

TEL: 1-609-573-6250 FAX: 1-609-573-6295

Edmund Scientific Co.
Dept. 14B1, N935 Edscorp Bldg., Barrington, NJ 08007

Circle number 72 on Reader Service Card

The reader should be further cognizant that the data shown in figure 3 have now been remeasured using the EOS chamber in California,⁸ and the bounce-off effect transverse momentum distribution may in fact be quite different from the original measurements with the Plastic Ball detector at the Lawrence Berkeley Lab's Bevalac, especially at low and high energies.

References

1. J. Molitoris, H. Stöcker, H. Gustafsson, J. Cugnon, D. L'Hôte, *Phys. Rev. C* **33**, 867 (1986).
2. H. Stöcker, W. Greiner, *Phys. Rep.* **137**, 277 (1986).
3. S. Shlomo, D. Youngblood, preprint 92-04, Texas A&M University Cyclotron Institute (1992).
4. H. Kruse, B. Jacak, J. Molitoris, G. Westfall, H. Stöcker, *Phys. Rev. C* **31**, 1770 (1985).
5. C. Wong, *Phys. Rev. C* **25**, 1460 (1982), and refs. therein.
6. For example, C. Gregoire, B. Remaud, F. Sebillie, L. Vinet, Y. Raffray, *Nucl. Phys. A* **465**, 317 (1987); A. Bonasera, F. Gulminelli, *Phys. Lett. B* **275**, 24 (1992).
7. J. Molitoris, D. Hahn, H. Stöcker, in *Progress in Particle and Nuclear Physics*, vol. 15, A. Faessler, ed., Pergamon, New York (1985), p. 316.
8. M. Partlan *et al.*, *Bull. Am. Phys. Soc.* **38**, 999 (1993).

JOSEPH J. MOLITORIS
Alexandria, Virginia

5/93

Thank you to the editors of PHYSICS TODAY for the publication of the exciting article on relativistic heavy-ion physics at the Bevalac at the Lawrence Berkeley Laboratory.

Among the numerous scientists mentioned in the article, at least one name is missing: Hermann Grunder. He was the key person in the creation of this unique facility from two existing obsolete accelerators, and with his vision of a promising outlook for this new field of nuclear physics he stimulated and vigorously supported the experimental activities. The article's authors completely ignored his effort and the engagement of the LBL accelerator division for both that project and its later upgrade to the first relativistic uranium facility in the world. More than usual, one feels the arrogance of experimentalists denying credit to those who provide their scientific environment and their tools.

One more detail: Since the beginning of the Bevalac experiments, the Gesellschaft für Schwerionenforschung was deeply involved in the enterprise. GSI not only contributed the Plastic Ball detector and other equipment but also provided a crew of up to ten scientists for a decade for the experiments with both that

detector and the Streamer Chamber. At least one of the article's authors, who was a member of one of the experimental groups, should have remembered this successful collaboration between the two laboratories.

RUDOLF M. BOCK
Gesellschaft für Schwerionenforschung
6/93 Darmstadt, Germany

DAS GUPTA AND WESTFALL REPLY: Concerning Joseph J. Molitoris's statement that "any attempt to extract central densities and temperatures of nuclear collisions is extremely model dependent," we hasten to point out that the theoretical calculations directly compute observables that are measured in experiments. We used the word "temperature" in the introduction in a loose sense, following widely used practice. In the article we do not extract a central density or a temperature. There is no mention of temperature in the actual calculations described. We actually warn against using temperature and say that "we require a dynamical model to simulate the collision without any assumptions regarding thermal equilibrium." As for high densities, we clearly state that we are discussing "theoretically expected maximum densities." Any reasonable theoretical model will show a rise in density in heavy-ion collisions in the energy range of concern in the article.

We agree that we do not start from a fundamental nucleon-nucleon force and deduce everything from there. Real many-body problems (as opposed to model ones) are too complicated to allow one to do that. Actually we feel quite good about using nucleon-nucleon cross sections obtained from two-body data, momentum dependence obtained from the energy dependence of experimentally measured optical potential, and other features of the mean field obtained from experimentally measured saturation density and binding energy. With regard to the warning that "the quantum content of the BUU method is rather limited," in the article we offer a justification for using the method: "In nuclear physics the semiclassical Vlasov description leads to a bulk dynamics very similar to that obtained from fully quantal time-dependent Hartree-Fock theory, extensively studied in the 1970s." All the measurements referred to in the article are properties of the bulk dynamics. The present codes preserve the stability of ground states well beyond 100 fm/c, and besides, the transverse momenta we refer to are generated quite early in the his-

tory of the collision, in the first 25 fm/c. Thus the prediction of the theory with regard to flow is very stable. Although we did not mention limits on the incompressibility K in the article, we think that the heavy-ion data bracket the value of K between 180 and 260 MeV. We quoted the incompressibility value of 215 MeV because this was roughly the value Jean-Paul Blaizot used in a very well-known study of monopole vibrations.

Molitoris is wrong when he states, "The BUU code referred to by Das Gupta and Westfall was developed by Jörg Aichelin and patterned after a code developed by Hans Kruse and coworkers." The original version of the BUU code that we have in mind and on which subsequent calculations referred to in the article were built was developed initially in the summer of 1983, and results with that code¹ came out in February 1984. The reason we did not refer to all the versions of the BUU, VUU or Landau-Vlasov model is that the number of references in the article was limited by editorial policy. Thus we mentioned only a review article where readers could look up the basics of the theory. We did not mention the 1984 article either, which was the first of many similar calculations to follow. This limitation also explains why there is only one reference on the balance energy E_{bal} . That reference would bring the reader up to date on the subject.

With regard to the last line in the Molitoris letter, let us point out that the EOS time-projection chamber results are not published yet and that preliminary results agree with the Plastic Ball results. Let us also point out that as far as the article was concerned, figure 3 was meant to show only a qualitative trend. The actual fits for the calculation were for the Streamer Chamber data shown in figure 4 of the article.

The article was intended to cover physics research at the Bevalac. We heartily concur with Rudolf M. Bock's assessment of the crucial contributions of Hermann Grunder to the success of the Bevalac.

Also, we were definitely aware of the contributions from GSI. Although we do not allude directly to GSI itself in the main body of the article, GSI scientists are acknowledged in the text and in one figure.

Bock will be pleased to know that a complete history of the Bevalac, including accelerator and other technological developments, is being written by Catherine Westfall.

LETTERS

Reference

1. G. F. Bertsch, H. Kruse, S. Das Gupta, *Phys. Rev. C* **29**, 673 (1984).

SUBAL DAS GUPTA

McGill University

Montreal, Quebec, Canada

GARY D. WESTFALL

Michigan State University

East Lansing, Michigan

9/93

Two Laser Pioneers' Early Affiliation

My article "Physical Review Records the Birth of the Laser Era" (October, page 28) mentions the current affiliations of Arthur Schawlow and Ali Javan in the text on page 30 and in the figure caption on page 31. At the time of their early laser work, both Schawlow and Javan were affiliated with Bell Telephone Laboratories.

NICOLAAS BLOEMBERGEN

Harvard University

Cambridge, Massachusetts

11/93

Complexity Study: An Alternative History

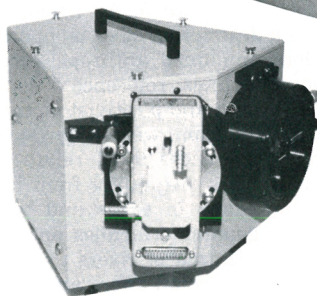
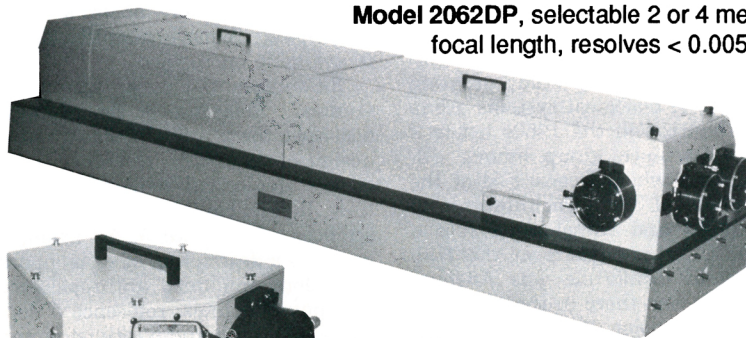
Philip W. Anderson's Reference Frame columns on "complexity" (July 1991, page 9; June 1992, page 9) are establishing and fixing a history of complexity study, and its relation to the Santa Fe Institute, in the physics community. This letter offers an alternative view on the history of such study. Even though Anderson asserted to me a decade and a half ago that the studies made by my colleagues and me should not strictly be considered physics but rather a scientific extension beyond or perhaps peripheral to physics, I believe members of the physics community should have the opportunity to learn about our contributions to a physical foundation for complex systems and to judge them if they so choose.

Those efforts began in the 1940s at the National Bureau of Standards in cross-disciplinary studies, of interest to government and industry, related to a variety of flow field and solid-state material problems within instrumentation and metrology and to the biophysics of high-altitude flight. They expanded with continuing systems studies in physiological physics and hydrodynamics in the 1950s and involvement in the organization of interdisciplinary sessions for the system regulation and control interests in the engineering societies from the 1950s on. Salient inspiration for such engineering physics studies came from APS's mixed-dis-

Spectrometers

High Performance Monochromators

Model 2062DP, selectable 2 or 4 meter focal length, resolves $< 0.005 \text{ \AA}$.



High Power

Model 272, $f/2$ aperture ratio, 0.2 meter focal length - superb throughput, unparalleled light collection. Serves as **Spectral Illuminator** also

McPherson offers a complete selection of monochromators, systems and accessories. Completely automated instruments with IBM compatible or Macintosh control available. Call for details.

McPHERSON™

In continental U.S. call
1-800-255-1055

530 Main Street, Acton MA 01720 • Tel: 508-263-7733 • Fax: 508-263-1458

Circle number 68 on Reader Service Card

PLACEMENT CENTER

To be held in connection with the Joint April Meeting of
The American Physical Society and the
American Association of Physics Teachers

18 - 20 April 1994

HYATT REGENCY CRYSTAL CITY HOTEL
CRYSTAL CITY, VIRGINIA

- The primary purpose of the Center is to arrange personal interviews between physicists seeking employment and prospective employers registered with the Placement Service.
- Universities, colleges, research institutions, industrial organizations and government laboratories are invited to participate in the Placement Center and conduct interviews with physicists attending the meeting. A **complete register of physicists** seeking employment will be available at a nominal service charge upon request at the meeting and after the meeting.
- A **Career Workshop** on Job seeking skills will be offered for all participants.
- Information regarding the Placement Center and Career Workshop may be obtained by writing to the Institute's office. The deadline for being Included in the Center is 25 March 1994.

Career Planning and Placement
AMERICAN INSTITUTE OF PHYSICS
One Physics Ellipse
College Park, MD 20740