The abstracts of the papers presented at this conference are published in the first volume of the second series of *Europhysics Conference Abstracts*. An amount of the total relative kinetic energy is dissipated within a relatively short time ($10^{-21}$s) leading to strongly non-isotropic angular distributions. The theorists are still trying to explain the mechanism responsible for these collisions. Are we facing a new, so far unknown, relaxation phenomenon?

Related to the above, the subject of resonant states observed in heavy ion collisions was given some attention too. The question to be asked here is the following: Would two colliding heavy ions coalesce immediately, mixing all their nucleons, or would they sometimes keep their identity for a longer time, say $10^{-21} - 10^{-20}$s and form a “molecular” state? Growing evidence exists for the creation of such states; their detailed structure is still subject to speculations.

Several contributions were dedicated to the subject of collisions of very energetic heavy ions with nuclei. These collisions raise the problem of the passage of nuclei through nuclear matter at speeds higher than the speed of sound (in nuclear matter) and the consequent propagation of shock waves. The speed of sound in nuclear matter is expected to correspond to particles moving with 10-20 MeV/nucleon; above that energy supersonic phenomena should start. For projectiles below $A \geq 100$, this is within reach of, e.g. the GANIL accelerator.

It would be difficult to imagine that the discovery of element 126 recently reported by Gantry et al. could have escaped the attention of the Conference. Last minute contributions from Orsay, Darmstadt, Oxford, Heidelberg and Marburg were, however, rather unanimous in reporting no evidence for superheavy elements in monazite (or other materials) within very low limits. The Darmstadt group reported on an experiment performed under conditions similar to that performed with the Florida State proton pencil beam. While bombarding the samples with 7 MeV protons showed the supposed superheavy L$_\alpha$ X-ray shoulder, bombarding with 2 MeV did not, thus strengthening the possibility that the shoulder be of nuclear origin, e.g. from the $^{140}$Ce ($p,\gamma$) reaction.

How about producing superheavies in the laboratory? Recent results from Berkeley with a 300 MeV $^{48}$Ca beam on $^{248}$Cf gave negative results. No trace of superheavy elements in the region of $Z = 110 - 116$ was observed. Still, theoretical predictions are not that pessimistic. Calculations based on the transport theory for deep inelastic collisions predict a total cross section for the production of 25 superheavy elements around $A = 298$ to be 0.1 mb for the $U + U$ and 1.5 mb for the $U + Cf$ reactions respectively. It is true that these calculations give the above numbers with a safety factor of 50; *Chi vivra, vedra!*

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**High Resolution Molecular Spectroscopy**

The IIIrd All-Union Symposium on High Resolution Molecular Spectroscopy held in Novosibirsk from 13-16 September 1976, follows in the line of biennial meetings in the USSR. In Novosibirsk, I found that in addition to about 80 participants from within the country there were 13 foreign scientists, including visitors from the USA, France, England, the German Democratic Republic, Czechoslovakia and Hungary. Novosibirsk may then become a truly international forum in the future. Over three days some eighty papers were read on the theory of, and techniques for high resolution spectroscopy and its applications. The apparent goal is to call the attention of physicists and chemists in the Soviet Union to this quickly developing field. Part of the reason for the pace of development is the availability of lasers. Tunable lasers allow the recording of ultra-high resolution spectra whose analysis necessitates a deep understanding of the quantum-mechanical behaviour of molecules. The Hamiltonian function of electronic ground and excited state molecules must be known to a high degree of accuracy requiring corresponding computational techniques.

It appeared that a significant theoretical contribution was the development of algebraic treatments of the higher-order Hamiltonians and the group-theoretical discussion of their symmetry properties. Reported examples of such achievements were in the theory of ro-vibrational spectra of molecules possessing one or two grossly anharmonic vibrational amplitudes, the treatment of asymmetric top rotational Hamiltonians, and scrutinies of the perturbation techniques for the mathematical analysis of high resolution spectra. An example of theoretical developments was connected
with spherical top molecules. The
impetus for such studies is given by
non-linear photophysical procedures
used presently to separate isotopically
substituted species of spherical sym-
metry, such as SFe.
The reports on high resolution optical
and microwave apparatus proved the
ready tendency in the USSR to
create a home experimental basis. The
most intriguing instruments were the
spectroscopic laser devices and the
now famous Gorky mm-wave spectrometer
with an acoustic detector. The impact of laser technology upon spectroscopy is demonstrated by the twenty-odd papers given in this field.

Since the Symposium was organised
by the Tomsk Institute of Atmospheric
Optics numerous papers were devot-
ed to atmospheric molecules, such as
water, CO₂ and ozone. The physics of
these studies is centred on inter-
molecular interactions influencing the
shape of individual spectral lines. Future needs are for more experi-
mental and theoretical work on line-con-
tours.
The Novosibirsk Symposium fits
well into the European series of high
resolution spectroscopy meetings in
Tours, France and Prague, Czechos-
lovakia. These conferences represent
a turnabout from chemical spectro-
scopy towards the more quantitative
methods of physical spectroscopy. The rigorous principles and procedu-
res of atomic and diatomic spectro-
scopy find a broad field of application
for the polyatomic molecules. The
greatest contribution of the Novosi-
birsk meeting is the promotion of this
kind of change of philosophy for poly-
atomics.
Finally let me add that Akademgo-
rodok Novosibirsk had a display of
young talent and enthusiasm, both
important and promising for the future
of this discipline.

I. Kovacs

Dilution Refrigeration and Its Applications

It is now more than a decade since
the first dilution refrigerators were
built and in the mean time these ma-
chines have become standard for
reaching temperatures between 10
and 300 mK in a continuously operat-
ing mode. Moreover, the technique
has spread beyond the area of purely
low temperature physics and is now
widely used in a number of fields.

Dilution refrigerators operate on a
mixture of liquid ³He and ⁴He making
use of the property that at low tem-
peratures the liquid separates into
two phases, usually known as the
concentrated phase and the dilute
phase according to the ³He concen-
tration. The thermodynamic properties
of the two phases being rather diffe-
rent, cooling can be obtained by forc-
ing ³He atoms from the concentrated
phase to the dilute phase, somewhat
analogous to a simple evaporation re-
frigerator but in fact more similar to
the Peltier cooling achieved by forc-
ing electrons across the boundary
between two dissimilar metals. The
operation of the conventional dilution
refrigerator, in which ³He is drawn out
of the dilute phase by a heated still
and the cooling caused by the balanc-
ing flow from the concentrated phase,
is sufficiently well understood that
machines reaching 10-12 mK are
available commercially.
However, in the past two or three
years, a number of improvements and
innovations have been made which
have allowed continuous operation to
temperatures of 3-4 mK, in other
words not far above the liquid ³He
superfluid transition. Since a great
deal of this recent work has been
done in Europe it seemed both timely
and appropriate for the EPS Low Tem-
perature Division to sponsor a study
conference on dilution refrigeration
this summer.
The study conference format suited
the subject admirably. Session lea-
ders introduced the topic under dis-
cussion with short 30-40 minute talks,
sometimes followed by one or two ad
hoc "contributed" comments of a few
minutes. Since refrigerators continue
to be temperamental creatures, both
in operation and conceptual, lively argu-
ment filled the greater part of the
time.
The conference which took place in
Lancaster from 25-27 September, was
roughly divided into, day 1, the con-
ventional refrigerator, or as the first
session leader described it the "Ge-
eneral Motors, rear-wheel-drive refrige-
rator"; day 2, applications; and day 3,
new or unconventional cycles.
Day 1 began with a historical intro-
duction to dilution refrigeration and
the basic thermodynamics of the cy-
cle using the concept of the enthalpy
balance to calculate the behaviour.
The optimization of performance was
then discussed with particular refer-
ence to the successful Grenoble
machines that routinely reach 4 mK.
One of the most significant results
reported was that using very fine sin-
tered silver heat exchangers these
temperatures can be reached and, as
important, that the performance of
each section of the machine agrees
reasonably well with calculations. The
day finished on a second high note
with a discussion of multiple mixing
chambers which have been develop-
ed in Eindhoven and more recently
at Grenoble. These devices allow
with very little extra effort, final tem-
peratures two to three times lower
than the single mixing chamber to be
achieved.
Day 2 saw the discussion of appli-
cations of refrigerators both for the
relative beginner and the expert in-
cluding a number of sophisticated
uses in nuclear physics, and there was
some discussion of the problems of
making thermal contact to the mixing
chamber. The day finished with a dis-
cussion of practical thermometry and
there was lively argument here too,
especially over the problems of dehy-
dration of CMN and of local moments
in platinum used for pulsed nuclear
resonance thermometers.
The final day saw the introduction
of the new cycle in which, instead of
extracting ³He from the dilute phase
in the mixing chamber using a still,
³He is pumped in through a superki-
This cycle offers the great advantage
that the dilute and concentrated pha-
ses counterflow in the same tube, ra-
ther than in separated tubes and no
heat exchangers are needed. The sim-
ple Leiden machine which reached
8mK very soon after having been
commissioned was discussed. Hybrid
machines in which a "Leiden" mixing
chamber is piggybacked on a conven-
tional refrigerator, and both ³He and
⁴He are separately circulated, as deve-
loped at Philips and Grenoble, were
also considered. The meeting finished
with an all-too-short session on runn-
ing problems and trouble shooting in-
cluding a very scientific look at leak
detecting.
The meeting was held at the Uni-
versity of Lancaster, no great distance
from the English Lake District and the