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ICPEAC XX: A RETRO- AND PRO-SPECTIVE ANALYSIS

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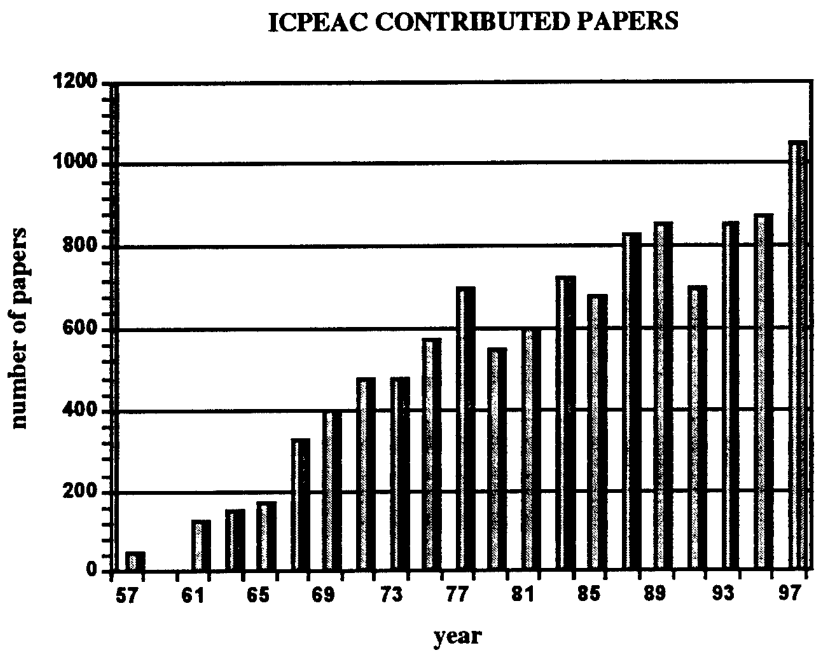
There is something magical about "round birthdays." They make one stop and think about where he is, how he got there, and where he is going. The same is apparently true of conferences, especially those like ICPEAC which represent the periodic coming together of a broad range of scientists in a reasonably well-defined discipline. This Vienna conference is the 20th in the ICPEAC series, and a retro- and pro-spective analysis seems appropriate. At the first ICPEAC in New York (1958), there were about 50 participants. In Vienna (1997), there were more than 800 participants. How do we account for this growth?

ICPEAC is one of the most democratic conferences of its size. For example, input from a general committee of ~50 representing the many geographic and sub-disciplinary areas gives continuous refreshment of ideas for the invited program. And, as in any democracy, there is a constant state of turmoil and self doubt. After all, atomic collisions is a "mature" field, and was a "mature" field at the time of the first ICPEAC in 1958, so what can one expect in new developments? This self doubt is best expressed in the comment of Ben Bederson (the "Father of ICPEAC") following the second in Boulder, Colorado, in 1961:

> ***"This conference is the second in a series of informal meetings organized by a group of workers in the general field of electronic and atomic collisions. The first such meeting was held at New York University in 1958, and we will probably continue to meet at irregular intervals in the future ...."***

As part of my "keynote" talk at the New York ICPEAC XVI in 1989,[1] I gave a brief history of the conference which we can build on to round things off for our twentieth. As a reminder, the year and location of past ICPEACs are as follows:

I	New York, NY	1958
II	Boulder, CO	1961
III	London, UK	1963
IV	Quebec, Canada	1965
V	Leningrad, USSR	1967
VI	Cambridge, MA	1969
VII	Amsterdam, the Netherlands	1971
VIII	Beograd, Yugoslavia	1973
IX	Seattle, WA	1975
X	Paris, France	1977
XI	Kyoto, Japan	1979
XII	Gatlinburg, TN	1981
XIII	W. Berlin, FRG	1983
XIV	Palo Alto, CA	1985
XV	Brighton, England	1987
XVI	New York, NY	1989
XVII	Brisbane, Australia	1991
XVIII	Aarhus, Denmark	1993
XIX	Whistler, Canada	1995
XX	Vienna, Austria	1997



First, let's look at the total number of contributed papers) versus year, shown above.

An analysis shows that, aside from steady growth, European conferences draw somewhat more than North American ones, and the numbers are reduced somewhat when the conference moves to less traveled areas. The point is though, that the secular trend is still upward! ("The reports of my death are greatly exaggerated" ... Mark Twain in a cable from London to Associated Press upon reading his own obituary in US papers). The demographics of ICPEAC XX are shown in Table I below. Representatives from 42 countries participated. The US delegation which used to comprise 30-50% of the conference has decreased in relative strength. The growth has occurred primarily in Europe and, especially, Japan. In what subject areas has this growth occurred? This is shown in Table 2 which shows the fraction of papers falling into the following categories; heavy particles (ions, atoms, molecules), electrons, photons, Rydbergs and collisions in exotic particles, (e.g., e^+, $\bar{p}$), and collisions with clusters or solids. We see no diabatic changes. There is slow decline in the once dominant fraction of heavy-particle collisions and a slow (albeit faster) growth of photon collisions, and collisions with clusters and solids. These trends were predicted in the 1989 paper.[1]

TABLE I

Country	Number of Participants
United States	137
Germany	126
Japan	117
United Kingdom	83
Austria	47
France	46
Russia, Denmark (each)	26
Australia	23
Brazil	21
Sweden	19
The Netherlands	17
Italy	11
Belgium, Spain (each)	10
Ukraine, Canada, Hungary (each)	9
India	8
Poland, Israel (each)	7
P.R. China	6
Switzerland, Korea (each)	5
Yugoslavia, Norway, Ireland (each)	4
Croatia, Taiwan, Argentina (each)	3
Macedonia, Romania	2
Uzbekistan, Czech Republic	1
Egypt, Georgia, Lithuania, Qatar, Mexico, Latvia, Slovenia, Slovakia (each)	
Total	**820**

TABLE II

Percentage of Papers in Sub-categories*

	Brighton 1987	New York 1989	Brisbane 1991	Aarhus 1993	Whistler 1995	Vienna 1997
Heavy Particle	41	37	35	34	32	31
Electron	33	35	37	34	31	31
Photon	15	16	15	16	18	21
Clusters & Solids	4	5	6	7	8	11
Exotics	4	5	5	6	8	5
Rydbergs & Fields	3	2	2	3	3	2
Total *	811	798	632	796	848	961

*Papers on experimental techniques and other related subjects are not included.

The growth of contributions in the photon-collision area to a size comparable to the heavy particle collisions and electron collisions has prompted the conference to vote to alter its name (but not its acronym!) to "International Conference on Photonic, Electronic, and Atomic Collisions"; the change is to be effective at the Santa Fe, New Mexico, ICPEAC XXII in 2001.

To judge recent trends, a reasonable comparison can be made between the last two European meetings: Aarhus in 1993 and Vienna in 1997. The relevant statistics are in Aarhus: 717 delegates from 42 countries of which 180 were pre-doctoral students and there were 866 contributed papers. In Vienna, the numbers are 820 delegates from 42 countries of which 206 were pre-doctoral students, and there were 1027 contributed papers. The ~160 paper difference is made up by ~50 papers in photon collisions, ~50 papers in collisions with clusters or solids, and the remainder distributed among the rest. Most encouraging is the increase in the number of students attending the conference.

The continuous rise in scientific output and hence in conference participation is related to the continuous improvement in experimental and theoretical capabilities which have opened new dimensions in both breadth and depth. An energy range of 25 orders of magnitude were spanned at this conference, i.e., 10^{-12} eV (~10 nK°) in papers dealing with the Bose-Einstein condensation and 10^{+13} eV in the work reported on 33-TeV Pb ion collisions at CERN. The development of multiply parallel computing systems which now approach Teraflop speeds have opened up heretofore undreamed of capabilities in computational physics.

How have techniques expanded since the first ICPEAC? Sources for obtaining beams of highly charged ions (up to U^{92+}) such as EBIS, ECR, and EBIT have broadened the number of atomic ions available for study from 92 to 4278! The availability of large particle accelerator facilities, e.g., GSI (Darmstadt, Germany) and SPS CERN (Geneva, Switzerland) permits the extension of collision experiment to ever higher energy regions.

Technology for the production of exotic species has shown much progress. Positron sources utilizing electron Linacs as a driver now exist in three places. The antiproton source, LEAR, at CERN is due for closure. However, an alternative system is being put together. The hope here? Anti-hydrogen.

Sensitive detection systems now include silicon surface barrier detectors, SiLi X-ray detectors, channeltrons, position-sensitive channelplates, and CCD cameras. Lasers which were "laboratory curiosities" in early ICPEAC days are now, in some forms, articles of everyday commerce with new modifications appearing almost daily. Femtosecond pulses permit stop-action photos of collision processes.

A relatively new arrival to our field, the free-electron laser (FEL), is yet to be fully exploited. Soft X-ray lasers lie on the near horizon. Synchrotron light sources supply intense photon beams with energies ranging up to the hard X-ray region. Fast electronics permit signal processing for multi-coincidence experiments such as COLTRIMS which has enormously increased the detail with which a collision process may be probed. Fast electronics coupled with modern computer techniques permit event-by-event recording for playback of experimental details which can be seen from different viewpoints.. Techniques for producing ultrahigh vacuum and for surface preparation and characterization open the study of collisions with well ordered solids.

Heavy ion storage rings enable relaxation of stored metastable atomic ions and relaxation of vibrational excitation of stored molecular ions. They permit greatly increased luminosity in collision experiments with, e.g., merged electron beams. Ion traps in which extremely low-energy collisions lead to cooling, ordering, and condensation yield information on long-range forces..

The above (incomplete) list of capabilities have themselves allowed the scientist to open entirely new areas for investigation in ICPEAC physics. Aside from our motivation in curiosity-oriented physics, much of our research is driven by the needs of other branches of science and technology. Examples here include gaseous electronics, chemical dynamics, accelerator technology, nuclear fusion, astrophysics, atmospheric pollution ..., and the list goes on. As scientists, we seek questions that need answers and very often find that the answers most worth getting are those which pose further questions.

Clearly, not all the well-known problems have been solved and not all the known experimental and theoretical techniques have yet been fully employed. This will take some time. After this is all done, is that all there is? There is a song from the American musical "Oklahoma" set in the year *ca.* 1900. The farmers sing about the wonders they have seen in the big city. The title is "Everything is up-to-date in Kansas City. They've gone about as far as they can go." Have they really? Of course not!

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[1] Sheldon Datz, "Keynote Lecture" - *Proceedings, XVI The Physics of Electronic and Atomic Collisions*, editors, A. Dalgarno, R. S. Freund, P. M. Koch, M. S. Lubell, and T. B. Lucatorto, AIP Conference Proceedings 205, American Institute of Physics, New York (1989), pp. 2-13.

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