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SUMMARY TALK

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Mr CHAIRMAN, ladies and gentlemen,

In the heart of France, in the gothic cathedral of the town of CHARTRES, there is this beautiful stained glass window made in the XIII century. It represents dwarfs on the shoulders of giants : a visual image of a powerful concept.

The men of today can perceive distant things, because they stand on the shoulders of the giants who, in the past, have prepared the way.

I think that this is a good image of our situation in the nuclear data field.

This conference has given outstanding examples of achievements, as seen from the data application point of view, which is the subject of my summary. These achievements allow us to meet many very stringent technological requirements, both in design and in safety.

I will first try to illustrate some of these achievements. Afterwards, I will try to indicate areas where this conference has shown, in my opinion, that we still have some open problems. Some new directions for future work can also be indicated. I will conclude on the role of international collaborations, that has been often mentioned during this conference.

Achievements

I will put them in 4 categories : quality of the data ; data benchmarking ; consistency of integral and differential data ; data availability.

1. Quality of the data

I will put in this category, the data for which the assessment of uncertainties, the check of the internal consistency and intralaboratory comparisons, make the data highly reliable and complete.

- The U-238 resolved resonance data fall into this category. They are being extended to ∿ 20 KeV by a combined effort of ORNL and Harwell, satisfying the dreams of most reactor physicists. Their accuracy seems now to have reached a limit difficult to be surpassed.

- The Pu-239 resonance data are in a comparable excellent shape as the work made at ORNL with collaboration with Cadarache, seems to indicate. This seems also the case for the U-235 resonance parameters.

- The thermal and epithermal energy data for U-235, U-238 and Pu-239 have been the object of new extremely careful measurements. The shape of σ_f and η of U-235 and σ_c of U-238 have been re-assessed with careful experiments performed in several laboratories, in particular in Europe (Geel, Harwell, Grenoble).

- The Los Alamos work on the ^{7}Li (n,n't) reaction has clarified the situation for this important cross-section. However, the requested accuracy of $\pm$ 3 % seems not yet to have been achieved.

- This brings me to the standards file evaluation for ENDF/B-VI. This work, based on a new way to conceive evaluations, is an outstanding example of the assessment of a reference data base which can eventually be used internationally.

We look forward to the final act of this successful even if difficult story : the assessment of the associated uncertainties.

- Finally, let me recall a nice results reported by FORT on the convergence of integral and differential data in the case of the (n,2n) of Np-237 that answered a long standing requirement on the accuracy in the prediction of Pu-236 build-up.

2. Data Benchmarking

During the week we had a detailed presentation of the very extensive work of data benchmarking, performed in the frame of the JENDL project, before release of the version 3 of the file. It covers fission reactor core performances (LWR, FBR, HCLWR), minor actinides, fission products, shielding and fusion needs.

Elsewhere, in Europe for example for the JEF files, a similar extensive benchmarking has used both critical experiments and operating power reactor results.

This type of exercise will be from now on, an essential part of any new file up-dating undertaking.

However, the representativity and the relevance of the experimental benchmarks is to be verified carefully. Powerful sensitivity analysis tools are available to perform efficiently this task. Moreover, clean experiments should be selected, to avoid uncertainties related to calculation methods.

3. Consistency of Integral and Differential data

At the Santa Fe Conference, B. PEELLE, even if he did underline the "maturity" of the so-called adjustment techniques, said that the final paper on the subject had not yet been written. May be this is true also for this Conference. However, adjustments have to show that they are physically well founded, answering a wide range of requirements of reactor operation and design.

In this respect, this conference indicated that this is indeed possible, with the present understanding of the techniques. Both the Prof. KANDA group work at the University of Kyusyu and the D. SMITH work at ANL, were excellent exemples. The trend for more covariance data requirements seems to me to be well confirmed and data are becoming available.

4. Data Availability

This Conference did show that availability of data today means much more than "any data is better than no data".

Photon-production data (both for fission and fusion application), double differential data, activation data, have been scarce in the past and now the situation has improved dramatically.

However, I think that it is now necessary that we, users, verify if we are able to use in a right way these data (do we really have reliable processing codes ?), and we should define realistic target accuracies.

There, as in other cases, the key-word is "uncertainties".

Finally, I was fascinated by the large data bases that are becoming available for neutron and other interaction data at intermediate and high energy for new applications (space technology, isotope production, accelerators etc...).

Open Problems

If I go now to open problems, I will mention a list of some of them, as I see things.

1) In the field of decay data and the related prediction of reactors decay heat, despite the outstanding increase of available data and studies, we still feel the need of a synthesis of the interesting theoretical developments and of the high quality new experiments, to eliminate discrepancies such as the one at cooling times of 10^3 seconds for Pu-239. Are we ripe for a new standard ? A first step should be to renew the B. SCHENTER pioneer work on uncertainties and I found Prof. RUDSTAM remarks very appropriate. An international task force could be suitable to cope with such problems, and the NEANDC may discuss that possibility.

2) After the Bimingham meeting and the presentations made at this Conference, the differential delayed neutron data seem to have reached a degree of accuracy, such that inconsistency with integral β_{eff} measurements in critical assemblies should be eliminated. Probably, in this field, a clean integral experiment made in the frame of an international collaboration could be a useful step. I think that the present uncertainty, associated to the reactivity scale assessment in a reactor ($\pm$ 10 %), can be easily reduced by a factor of two.

3) The appropriate use of the new resonance data for U-238 and Pu-239, which I indicated previously as a particular achievement pointed out at this Conference, should help to improve the present situation for the prediction of the main parameters of HCLWR, for which the international intercomparison sponsored by NEACRP, has indicated unacceptable discrepancies.

4) Pu recycling in LWRs suggests to make some more efforts in the thermal energy region data for Pu-239 and possibly Pu-241. The analysis of the discrepancies indicated by ROWLANDS for the K_{eff} of the nitrate Pu solutions can benefit from that work. Finally, it is worth to recall that the $\bar{\nu}$ energy shape can play a complementary role in the overall assessment of these data.

5) It should be emphasized that the high accuracy thermal region measurements for U-235 and U-238, have given confidence in the data themselves (consistency appears to have much improved), but that a large part of the past discrepancies of C/E on LWR temperature coefficients, still subsists.

The interest to look to possible solid state effects and to the Debye temperature of UO_2, was also indicated in the ROWLANDS review.

6) If we turn to the KeV energy region, there is still the feeling that the fission data of Pu-239 in that region need more consideration, and probably integral experiments can help the evaluators to select data in the 10-30 keV region.

7) There is still requirements for improved Inelastic scattering data, in particular for even-even fission product nuclei and, not surprisingly, for.... U-238.

8) The data for some important cross-sections for fusion applications, still need clarification. This is the case for example of the (n,2n) of Pb and Be.

9) Finally, I will add a personal remark, related to the assessment of control rod worth in large LMFBRs. The SUPER PHENIX 1 start-up experiments have clearly indicated that, besides the typical reactor physics difficulties of making good calculation models, basic data uncertainties still have a large impact on design method performances. And, probably, basic data are responsible for the spatial C/E variations on control rod worth observed both by US and Japanese analysis of the same critical experiments for large and decoupled cores.

New directions

Very briefly, new directions and challenges are found in space technology and bio-medical applications, and I refer as an example to the paper on the use of the FFTF reactor for isotope production.

Possibly, data needs will become evident if a reactor for waste incineration purposes is considered, as we have heard from our Japanese collegues.

Also, new fuel types, new shielding materials, or long burn-up concepts for future reactors to meet economic requirements, can trigger new data needs.

The role of collaborations

Before concluding, let me indicate that one of the most important challenge that we face, in my opinion, is the enhancement of international collaborations. This conference has brought same good news. I am confident that there is the willingness to go further in that direction, with more coordination of efforts. My hope is that the next conference of this series will bring even more good news on this subject.

I will stop here, Mr. CHAIRMAN. I am aware that my summary is certainly incomplete. But I will apologize, recalling that once Yoshida Kenko wrote in the Tsurezuregusa : "heaving something incomplete makes it interesting, and gives one the feeling that there is room for growth".

Finally, I like to thank deeply our hosts and organizers of this extremely successful Conference.

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SUMMARY TALK II

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The task assigned to me from the Program Committee of this conference is to give a closing talk from the viewpoint of the theorist and evaluator of the nuclear data.

Many different aspects have been covered at this Conference. But, I cannot touch on all of them. So, in this summary, first, I would like to give my general impression for papers presented in Conference Topics A, B, F and G. Then, I would like to comment over a few theoretical papers in Topics D and E in which I am personally interested.

For fission reactors, great efforts for measurements and evaluations of both the differential and integral data have been made as in the past. Above all, we were informed that the compilation of JENDL-3 is now in a final stage, and the evaluated data for main nuclides had been stored in a temporary file called JENDL-3T. In this connection, various bench-mark tests of JENDL-3T, i.e, for thermal and fast reactors, for shielding problems, etc. were reported. We are delighted to know that JENDL-3T has reproduced experimental values fairly well.

The nuclear data involved in high conversion light water reactors (HCLWR) and in reactor safety, and in fuel reprocessing were reviewed, and the activity of data compilation of the activation cross sections was reported. These are fresh subjects as far as I am concerned. It was impressive to hear that differential data for actinides are not yet satisfactory in preciseness. Results of several elaborate calculations for actinide reaction cross sections were reported.

Decay heat problem was discussed theoretically by two authors. The one is by Dr. Klapdor from the standpoint of the microscopic approach. The another is by Prof. Yamada from the statistical point of view.

The microscopic calculation seems to be very interesting and ambitious. But, in order to get accurate results, precise wave functions for parent and daughter states are needed and usually elaborate calculation should be performed, even for the decay of a stable nucleus. For evaluation of the decay heat, one has to treat many states of many nuclei which lie far from the beta-stability line. So, this approach may have some disadvantage from the practical point of view.

Recent progress in the gross theory of beta-decay was explained by Prof. Yamada. Effects of the improvements were discussed on the average beta-and gamma-energies, and delayed neutron emissions. Decay-heat calculation has not been done yet. But it is expected to yield better result than before. Furthermore, we were encouraged by many reports concerning precise measurements of average beta-energies, the half-lives of short-lived nuclei and of delayed neutrons.

For fusion reactors, measurements and evaluations of both the differential and integral data were reported in rich manner, quantitatively as well as qualitatively. Results of integral experiments were analysed by use of several standard data files and some valuable suggestions were made for their improvements. Here, again the validity of JENDL-3T was examined.

As for the evaluation of the fusion nuclear data, there are some difficulties due to the individualities of light nuclei and the high energy of the neutron. For latter feature, the direct reaction theory and the pre-equilibrium(PEQ) model are usually adopted for the evaluation. In nowadays, the direct reaction theory is well established, but PEQ model is still less. I will comment on PEQ model later.

We may say that the nuclear data necessary for the fission and fusion reactors have been well examined from the nuclear theoretical point of view, however the current nuclear theory is intrinsically not so precise and hence the evaluated data are still unsatisfactory from the engineering point of view.

As is generally known, we can take precise data up to (say) 80% rather in short time, but have to spend a considerable long time to take preciser or the precisest data. The situation is quite the same for theoretical work. Nevertheless, we should make utmost efforts to attain the preciseness which meets the technical necessity. This may be the reason why many international collaboration programs are going on in the field of nuclear data. However, it is also true that such a work demands us the patience and is usually less exciting and few surprises.

In recent years, the aging of nuclear data community becomes very serious problem. In order to appeal young people, I think, we should open up a new field, in addition to the traditional work by experts.

At this conference, we have heard many reports on the nuclear data for medium and high energies. They are papers related to the spallation sources, the accelerator shielding and the incineration of long-lived radioactive wastes by use of high energy proton and gamma-ray, etc. Intranuclear cascade model has been adopted for the calculation in many cases, and very interesting results are shown, suggesting necessary improvements. This may be one of new directions which we should go ahead.

Next, I would like to touch upon a few theoretical papers in which I am personally interested.

The first is the paper BE05 concerning the level density. The authors have proposed the temperature dependent level density parameter a(T). It seems to me that their shell structure energy is a quantity similar to the shell correction energy which is introduced by Strutinsky to explain the double-humped fission barrier. Although the temperature dependence of the level density parameter a is a novel feature, the theoretical derivation of shell structure dependent a is also quite interesting. Effects of the nuclear deformation on a deserves to be explored.

The second is the paper IE03 on the fission theory. In this paper, the recent progress of the fission theory from the point of view of diffusion process is reviewed. The content is mainly relevant to the heavy-ion-induced fission, i.e. the fission associated with the high excitation and the high angular momentum. However, such an approach will certainly be useful for understanding of the dynamics of the neutron-induced fission, too.

The third is the papers discussed about the pre-equilibrium(PEQ) process in nuclear reactions. As is clearly explained by Prof. Uhl in his nice review talk, the exciton model is widely used for the calculation of PEQ process induced by fast nucleon for medium-weight and heavy nuclei, and succeeds in reproducing experimental data fairly well. However, there may be room for improvement. The exciton model currently used is formulated for a single kind of nucleon. It seems to me that the reformulation taking into account the existence of the two kinds of nucleons, i.e. neutrons and protons, is essential to the improvement of the model. One interesting paper BE09 which treats this problem has been reported.

Another insufficient point of the exciton model is concerned with the angular distribution. The generalized master equation of the exciton model yields the double-differential cross section in semi-classical manner. It is well known that the wave nature of the particle such as a diffraction exerts a great influence on the angular distribution. Therefore, the quantum mechanical treatment seems to be necessary for the correct description of the angular distribution.

Prof. Hodgson has stressed that the quantum-mechanical treatment is very important for the calculation of the angular distribution. I completely agree with him. He has shown several angular distributions calculated with Feshbach-Kerman-Koonin(F-K-K) theory for (n,n') and (n,p) reactions, which agree quite well the experiments. However, I wonder if it will not be so easy to define P-and Q-chains in F-K-K theory for the composite particle emission, such as (n,α) reaction.

An approach which enables to calculate the angular distribution of the composite particle emission, semi-quantum mechanically, has been developed by Dr. Plyuiko in USSR and Dr. Fu in U.S.A., but unfortunately no contribution has appeared in this Conference. I think such an approach will be worthy to proceed further.

Before finishing, I would like to apologize for my prejudiced summary. I have done it from necessity, because I have not had a time to digest all of interesting papers presented at this Conference.

I would also like to say our deep thanks to members of the organizing committee of the Conference for their nice arrangement and to secretaries for their careful treatment.

Thank you very much for your attention.

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SOME PERSONAL REFLECTIONS

by

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Introduction

As the final player in this scene, I would like to convey some personal reflections on this Conference. I believe that is fitting and proper, as the two previous speakers have given a comprehensive technical overview. My reflections will mirror my personal interests: microscopic experiments. I shall not attempt to "touch all bases" (my Japanese friends will understand that terminology, as they play a good game of baseball); rather, I shall only cite selected areas. The views may be right or wrong, but hopefully substantive. I may well be criticized for the opinions, but I am too old a fox to worry.

Some General Trends

I sense a trend, from the strong focus on engineering fission-reactor data of the previous such conferences to a diversity of other applications of nuclear data, particularly to fusion-system data. This trend is healthy and should be encouraged if the field is not to stagnate.

In the beginning, the keynote speaker stressed the importance of international cooperation. This theme emerged elsewhere throughout the Conference. Cooperation is increasingly important as resources become more limited throughout the OECD area, and the technical issues are more quantitative and demanding. Cooperation has been essential to the successful solution of some of the most troubling problems, as demonstrated by the results of the ^{56}Fe and ^{238}U task forces we have just heard described. Similar successes were evident in a much wider scope (e.g., the JUPITER program and the cooperative fusion-blanket programs). It seems to me that, in this context, the future is clear: there should be increased international cooperation, extending from the initial concept to the final evaluation, and beyond.

At the 1978 Harwell Conference, William Hannum pointed out that emergency engineering needs for nuclear data were relaxed, and thus there was an opportunity to enhance the underlying physical understanding. This concept was extended at the 1985 Santa Fe Conference by Michaudon to include the most fundamental investigations of the neutron-nuclear interaction. In my view, the results of these suggestions have been mixed. Some very impressive fundamental studies have been described (e.g., astrophysical investigations; a deeper understanding of the fission process; and the potential for fundamental studies of the nucleus, such as the search for parity violation). However, the Conference emphasis remained on applied engineering issues.

Some data problems are of a statistical nature and are very specific (e.g., detailed resonance properties), and there appears no alternative to explicit, point-by-point experimental investigation. Other classes of problems lend themselves to model interpolation, coordinating experimental measurements and calculational interpolation for optimum efficiency. The latter approach was not much in evidence. In the future, selected measurements could well be guided by the objective of validating calculations that subsequently provide the desired information, possibly even extending to the substitution of model parameterization for lengthy listings of redundent numerical quanitites. For example, why do we measure a multitude of energy-averaged total cross sections when a far more limited but precise data base can be well interpolated with the conventional optical model? The implementation of such a correlated measurement and calculational approach would mark a fundamental and valued change in measurement philosophy.

Data for Fission-Energy Development

There was a wealth of new fast-neutron-fission cross-section data, extending from several hundred keV to > 14 MeV, and, in one instance in a preliminary manner, to ≈ 400 MeV. Below ≈ 20 MeV the consistency of the results is very good. The values are generally ratios (to ^{235}U), with accuracies in the ≈ 1.5-3% range. A careful horizontal evaluation is needed to determine the exact situation, but I estimate $\delta\sigma_f \approx$ 1-1.5% from 0.2-20 MeV for the prominent actinides. Any future σ_f ratio measurements must be very precise ($\delta\sigma$ < 0.5%) if they are to make appreciable impact. Such precise measurements will not be easy as they must address the mass scale and the ^{235}U standard, in addition to the ratio determinations themselves, to new and heretofore unattainable accuracies. In view of the magnitude of such an endeavor and the present status, I doubt that the fast-fission cross sections of the common actinides will be much improved in the foreseeable future.

The low-energy fission and capture cross sections of ^{235,238}U and ^{239}Pu have long been a matter of concern as macroscopic thermal-reactor characteristics appeared inconsistent with microscopic cross section values. This "discrepancy" is a safety concern, highlighted by the Chernobyl accident, and it was recently studied by the NEACRP. Perhaps that accident motivated an extensive set of experimental measurements. In any case, some remarkably accurate low-energy actinide cross sections were reported at this Conference. These results show minor differences in normalization and structure from widely used evaluations, but generally there were no surprises. Thus, I feel that the "discrepancy" lies with the integral measurements and/or their interpretation, rather than with the microscopic data. It should be noted that the techniques employed in these precise measurements have a wider and more fundamental applicability, extending to the study of the basic properties of the neutron.

At this Conference we have seen a unique convergence of: 1) the results of a decade of precise measurements of $^{235,238}U$ and ^{239}Pu resonance properties; 2) interpretations by outstanding specialists at the peak of their professional capability; and 3) the application of the best physical models and fitting procedures. I doubt that this combination will occur again in my lifetime. The results, now nearing completion, are of a unique quality, and probably will meet the majority of fission-reactor needs for actinide resonance data into the foreseeable future. Improvements may very well be impossible with contemporary understanding of physical mechanisms and measurement technologies. This achievement in the area of actinide resonance properties is to me an outstanding aspect of this Conference. There was some additional high-quality resonance information of relevance to fission-energy development, notably in the structural-material region, but otherwise new resonance information was limited.

Fast-neutron capture (primarily in ^{238}U) remains a concern, and I found no new information at this Conference. Perhaps that is to be expected, as the fast capture in ^{238}U was a part of the unified evaluation for ENDF/B-VI standards, and the results, with uncertainties, are not yet available. I very much look forward to seeing them.

Actinide neutron scattering (or any scattering of fission-reactor relevance) was notable for its absence at this Conference. There was a single paper, dealing only with the excitation of vibrational levels in ^{232}Th. The general lack of new scattering information is disturbing, particularly in view of the fact that, for example, ^{238}U inelastic scattering continues to adorn high-priority request lists (as it has for many decades). The respective measurements are tedious and difficult, the analysis tools are deficient, there is little fundamental interest, and no experimental breakthoughs are in sight. These factors have likely conspired to result in an evident lack of progress.

Despite the inherently safe Integral Fast Reactor with its complex fuel cycle, the importance of fuel cycles generally, and the concern for large inelastic-scattering cross sections (reiterated at this Conference), there was little new microscopic fission-product information. In view of the applied importance, and the interesting fundamental aspects of the fission products, this is puzzling.

Some very impressive fundamental studies of the fission process were presented, including energy, angle, mass, charge, and particle correlations. However, the impact on gross nu-bar and fission spectra for reactor calculations was modest.

There was little microscopic dosimetry information, though the long-standing $^{93}Nb(n,n')^{93m}Nb$ issue appears to have been resolved.

Data for Fusion-Energy Development

This was perhaps the strongest microscopic measurement aspect of the Conference, driven by Japanese interest.

A wealth of double differential neutron emission data was presented, largely at incident energies in the 14-20 MeV range. The distributions are characterized by reasonably known compound and pre-compound contributions and by less well-known direct-reaction components resulting in structure in the higher-energy portions of the emission spectra. The latter phenomena are experimentally manageable, and they will soon be better defined. At energies < 14 MeV, the comparable experimental information is only fragmentary. That is a region where there is an interplay between (n,n'), (n,2n') and (n;n',p) processes, and calculations suggest large spectral changes over relatively small incident-energy ranges. These lower-energy emission spectra are important to fusion-energy programs, and their quantitative study will not be easy, particularly in the 10-14 MeV range. Of course, one must remember that experimental emission spectra are a sum of components from a number of processes, and thus calculations must be used to break the observed spectra into the various components appearing in the evaluated file systems. Thus, measurements only test the gross features of the calculational systems and do not directly provide the individual components requisite for the evaluated files.

The primary fusion-fuel reactions (e.g., (d,t)) were not discussed at this Conference. This is not surprising as they are well known from careful measurements, extrapolated with theory.

This Conference produced little new information on energy deposition resulting from neutron induced charged-particle reactions (e.g., Kerma values). This is a concern, as those are major heat-transfer processes and they are essential for maintaining energy balance in the data system. The requisite measurements are difficult and have been largely concentrated about 14 MeV. Extending these experimental results to the lower energies will be difficult as the source properties are far less favorable than at ≈ 14 MeV.

There are very large needs for fusion-activity data. A few of those problems are straightforward engineering matters, but many are very difficult and will require new measurement techniques for definitive results (e.g., the use of unfolding methods, as described by a paper at this Conference). Several nice papers by Japanese authors dealt with activity measurements. However, the fusion activity needs are of a magnitude grossly exceeding the apparent respective experimental endeavors. As a consequence, large portions of the evaluated activity files are calculational estimates. This is particularly an area where a few well-chosen, if difficult, measurements should be used to validate calculational methods that will have to be used to provide the majority of the data base.

The uncertainties in the neutronic data for the lead and beryllium multipliers are of magnitudes that may well make or break entire fusion concepts. The lead case appears to be largely an (n,2n') problem, and the more tractable of the two. The beryllium issue seems the more complex, with less certainty as to where the problem lies. These are serious issues that must be resolved by a combination of microscopic measurements and macroscopic tests, and that will not be easy.

Facilities

Realistically, future facility improvements will be more evolutionary than revolutionary. It is reasonable to expect improvements in both intensity and time resolutions, with the largest relative potential increases with modest resources probably in the monoenergetic source area. Monenergetic and white neutron sources will continue to be used in a complementary manner, particularly as the important data problems become increasingly quantitative and precise. In such cases the use of alternate and well-understood facilities and techniques is very desirable, as was illustrated by the precise studies of the ^{235}U σ_f standard cross sections reported at this Conference. It is unlikely that the data field will ever again alone support a massive new facility. Therefore, future large new data facilities will be in concert with other, and dominant, research endeavors (e.g., condensed matter and fundamental-particle studies). Such correlation will inevitably result in some compromise in concept and operations. One such massive new facility (based upon spallation reactions) was described at this Conference, with results characterized by both the very large and the very small: the intensities making possible studies of very small rare and active samples that must be difficult to see, the large energies not elsewhere available at white-source facilities, and the potential for very fundamental studies. It will be interesting to watch progress with this new approach.

Instrumentation

This area is characterized by elegant refinement. No breakthroughs, such as a GeLi detector, black detector, etc., were evident. The nature of the progress was illustrated by the very excellent refinement of ion chambers and electrostatic-magnetic devices in complex studies of the fission process. I do have a bit of Freudian concern for these fission apparatii. They seem so unhappy, with grim Wagnerian names like Tristan, Isolde, Lohengrin, etc. Can not we have a happy detector, perhaps Falstaff? Another refinement that appears to have good potential is the use of solid-state devices for obtaining high quality beta spectra. More mundane, but of equal importance, is the improved understanding of conventional detection methods that has resolved long-standing issues; e.g., the energy-dependent sensitivities of γ-ray detectors used in studies of capture processes generally, and the 1.15 keV resonance in ^{56}Fe specifically. It seems odd to me that such uncertainties in the characteristics of relatively conventional devices have so long existed.

There was little overt note of what I feel is an instrumental advance that has the potential for profound impact on many aspects of the nuclear data activity: the advent of mini-computers (i.e., workstations), putting at the desk top the computational power of a significant fraction of a super computer, all at truly modest capital cost. I expect a very large impact by these systems on simulations (as illustrated by a facility study reported at this Conference), data handling, and modeling and interpretation. Computational power, never before practically available, is now routine and is being exploited (e.g., in extensive R-matrix calculations). Moreover, these systems are in a highly developmental mode, and it is reasonable to expect a rapid enhancement in their capability, extending to parallel-processor systems.

Uncertainties

I have the feeling that there has been a rather carefree use of uncertainties and correlations. Their importance in the nuclear-data activity was stressed more than ten years ago by Perey. However, it seems that reality has set in. Rigorous practical use of uncertainty concepts in nuclear-data measurements and interpretations is not trivial. Oddly, I have the impression that integral studies have more carefully addressed the issues, as illustrated by papers at this Conference. I fear that, unless we are careful, rigorous and proper application of uncertainty principles to microscopic nuclear-data measurements will go into default, and, if so, a powerful tool will be lost, along with the potential for applying innovative new measurement techniques (e.g., the use of unfolding methods).

I would like now to turn from technical commentary to:

MATTERS OF APPRECIATION

I must express my personal appreciation for this fine Conference and the gracious hospitality shown by my Japanese hosts. In a bigger scope, I have been fortunate over the years to have a number of outstanding Japanese visitors with our group. They bring the ability, industry, culture and youth that we sorely need.

Now I would like to take on a different robe, that of NEANDC Chairman. The NEANDC, and its previous reincarnations, has sponsored conferences of this nature since 1955. This Conference is the most recent and among the most noteworthy. On behalf of the NEANDC and, I believe, all those present, I express our most sincere appreciation for this Conference and the outstanding hospitality, and for the opportunity to learn so much from our skilled Japanese associates. This expression extends to: the Japan Atomic Energy Research Institute and all its personnel, to other commercial and professional sponsors, to those who worked so diligently and successfully in preparing for this Conference, and particularly to the Vice-Chairman of the NEANDC, Dr. Igarasi, who provided the essential leadership and direction for this Conference.

I leave you now, not knowing when, or whether ever, I shall return. To each of you my very best personal wishes.