Vol. 30 Nos 3 & 4 Sept & Dec. 1999

PHYSICS NEWS VOL. 30 1999 (SEPT-DEC)

THE INTERNATIONAL PHYSICS OLYMPIAD -1999

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Abstract

The International Physics Olympiad was held in Padua, Italy from July 18 -27 1999. This year marked India's second foray into this exciting event where sixty-two nations participated. As the leaders of the Indian team at Padua we were privileged to be in the thick of action. This report describes our preparation and participation in an event which we believe may be described as a festival and as a "celebration" of the best in high school and pre-college physics. Our performance was creditable: all [illegible] participants won medals, garnering four silver and one bronze. Out of the five spe[illegible] prizes, one went to a member of our team. The report concludes with pertin[illegible] observations and some personal notes.

Preamble

Competitive exams are not a new feature for the urban Indian household. At the post-graduate level the IAS and Civil Services Exams, GATE, and the Combined Admissions Test for the top management schools are some of the buzz words familiar to most of us. At the high school level and pre-college level, the Joint Entrance Exam (JEE) conducted by the Indian Institutes of Technology (the IIT's) is considered by many to be the ultimate test of competence in Physics, Chemistry and Mathematics. The Indian Association of Physics Teachers (IAPT) has been conducting its own Physics competency test, the National Standard Examinations in Physics (NSEP) for the last several years. But now we have what we consider, a truly comprehensive test for competency in Physics for high school and pre-college students, namely, the **Indian National Physics Olympiad** at the national level, and **International Physics Olympiad** at the global level.

The International Physics Olympiad is an annual event initiated by erstwhile East European nations three decades ago. India has been a late-comer to this event which is part festival, part competition - in short a celebration of pre-college physics. We participated for the first time last year. This year was our second foray into this exciting event. We were the two leaders of the Indian team consisting of five pre-college (Standard. XII) students which participated in the XXX International Physics Olympiad at Padua, Italy from July 18 - July 27 1999 [1]. We participated in the training and selection of our team, gave tips and advice to them in Italy. witnessed their participation and shared the agony and the eventual ecstasy during the prize-distribution ceremony. In short, we were privileged to be in the thick of events.

Preparation

The implementation of the Physics Olympiad programme is jointly carried out by a voluntary body, the Indian Association of Physics Teachers (IAPT) and the Homi Bhabha Center for Science Education (HBCSE), Mumbai. The latter is a National Center set up by the Tata Institute of Fundamental Research (TIFR). The IAPT conducted an all India exam called the National Standard Examination in Physics (NSEP) in December 1998. Over 17,000 students appeared in this exam. The IAPT then identified about 200 meritorious students across the nation. These students appeared

for the Indian national Physics Olympaid (INPhO) held at ten centers in different parts of the country in May. INPhO was conducted jointly by IAPT and HBCSE. It had both a theoretical and an experimental component. Approximately 35 students were selected to receive the NSEP-INPhO gold medals and they underwent a three-week training programme at HBCSE, Mumbai from May 24 to June 12 1999. Several selection tests were administered during the course of the camp. The top five students were identified to receive merit awards and to represent India in the XXX International Physics Olympiad (IPhO) in Padua, Italy. The selection process was rigorous in the extreme.

The procedural and funding aspects of the selection procedure have been described earlier [2,3]. The programme is mainly funded by the Department of Atomic Energy (DAE) under its Board of Research in Nuclear Sciences. The international travel of the team is supported by the Ministry of Human Resource Development. The syllabus with certain notable exceptions overlaps with our XII Standard pre-college syllabus. The statues, syllabus and eligibility criteria of the Physics Olympiad have been described elsewhere [4].

Padua, Italy

We arrived in Padua on Saturday, July 17, a day before the official commencement of the Olympiad. The University of Padua was founded in AD 1222. It is probably the oldest university in Europe. Galileo taught there for fifteen years. Copernicus also spent time there. William Harvey, the discoverer of the human circulatory system studied at this University. The Physics Department houses a museum boasting of experimental apparatus two centuries old. Being in Padua was a rare treat.

The question papers, both experimental and theoretical, are prepared by a Scientific Committee which traditionally consists of physicists from the host nation. Nevertheless, the questions are discussed and debated and finally have to be approved by the International Board consisting of the two leaders from each participating nation. With sixty-two nations participating, there were over a hundred members who assembled on the evening of July 19 to consider the experimental question prepared by the Scientific Committee. This year they proposed one question which concerned a torsion pendulum exhibiting a bifurcation and carried a total of 20 points. The question was at the nuts and bolts level, a purely mechanical experiment. It involved no electronics or sophisticated instrumentation. The Board was impressed with the fact that this "supposedly" simple mechanical exercise had been given a modern twist, namely the student was required to investigate bifurcation. Bifurcation is associated with symmetry breaking, and is one of the central themes in contemporary physics. With minor modifications the question was passed [5].

The students took the experimental exam of five hours duration the next day on July 20. While they were busy with the exam, we, the team leaders, were taken on a day long trip to the Italian Alps. That night we were given photostat copies of the experimental answer sheets of our students. We were required to grade them and turn them in the next day. As we sat through the night, we became painfully aware of the sad state of the experimental training in our nation. Our students did not perform well and we were left hoping that their performance in theory would shore up their overall grades.

The next evening (July 21) we, as the International Board, met for a marathon session to debate on the theoretical problems proposed by the Scientific Committee. There were three questions each of 10 points. The first question was on the absorption of radiation by gas. It involved application of the laws of thermodynamics. The second question on electromagnetism was by far the most interesting question. The magnitude of the magnetic field due to a current carrying wire was a hotly debated issue between Ampere on one hand and Biot and Savart on the other. To settle the issue Biot and Savart proposed that the magnetic field be evaluated on the axis of a V-shaped wire and further that this evaluation be confirmed by measuring the time period of oscillation of a suitably placed magnetic needle. Ampere was vindicated and his work was later embodied in Maxwell's

electromagnetism is now universally accepted. The atmosphere in the board when this question was proposed was electrifying and the question was accepted amidst thunderous applause. The third question, on mechanics, dealt with the space probe which is accelerated as it flies by Jupiter. This gravitational "boost" or "catapult" problem also met with approval. The problems are too lengthy to be reproduced here. The interested reader is referred to the Bulletin, IAPT [5].

We sat up all night translating and refining the theoretical problems with colleagues from the USA, Canada, etc. Although it was hard work we enjoyed it since it gave one an opportunity to interact with delegation leaders from other countries. The students took the exam the following day (July 22). It was a five hour exam where refreshments were served. A trip to the nearby Legnaro National Laboratories was arranged for us. That night we were given photostat copies of the theoretical answer sheets of our students. As we sat grading through the night, our despair turned to joy. Our students had lived upto our expectations in theory. In fact all of them had employed symmetry principles to solve the second question, a methodology we had drilled into them during the three week training camp in May-June at HBCSE. Their scores in theory ranged from 26.5/30 to 28.2/30, altogether a fine performance.

Presentation of Awards

On the evening of July 25 the International Board met to hear the decision of the Scientific Committee on the final markings and medals. The atmosphere was expectant and tense and one could see a few delegation leaders biting their nails. Prof. Paolo Violino, the President of the Scientific Committee presented the results. The Russians (four gold and one silver medals) and the Iranians (five gold medals) shared the top honours. The Russian student Konstantin Krastov with 49.8 out of 50 was the top scorer and received a special prize along with the gold medal.

Participating for the second time, our team performed creditably, winning four silver medals and one bronze medals. Thus all five students secured medals. Their names, affiliations and total scores are:

1. Raju Suvrat (Sardar Patel Vidyalaya, Delhi): Bronze (36.8/50)
2. Mr. Amit Agarwal (DAV Junior College Chandigarh): silver (39.8/50).
3. Mr. Harsha Madhyashta (National Public School, Bangalore) Silver (37.0/50).
4. Mr. Mayank Rawat (DAV Junior college, Chandigarh) : Silver (42.2/50)
5. Mr. Bala Sandeep (K.C. Junior College Mumbai) : Silver (41.0/50)

In addition to the medals, we secured one of the five special prizes awarded by the scientific committee of the XXX Physics Olympiad. This special prize was for the best solution to a problem based on a famous debate on electromagnetism in the last century (problem no.2 described above), and it was secured by one of our students : Raju Suvrat.

The cut-off was 37.0 and 43.0 for the silver and the gold medals respectively. Raju Suvrat missed the silver and Mayank Rawat missed the gold by a hair's breadth! For completeness we should mention that the cut-off was 24.0 and 31.0 for the honourable mention and the bronze medal respectively. In order to make it into the merit list the student should have secured at least 24.0 out of 50 this year. The Olympiad is an individual event and national rankings are not announced by the Scientific Committee. The maiden experience from last year where we secured 1 silver, 1 bronze and three honourable mentions was helpful to us. But for purposes of continuity and experience we felt that one leader from the previous year should accompany the team either as a leader or as an observer. Several countries, e.g. USA, Iran, Britain, etc. came with two leaders and at least one observer.

One of the surprise decisions was the award of the special prize for the best experimental work to the British student Tom Morfett. He had received 14.1 points out of 20. The Scientific committee chose to overlook the claims of dozens of candidates who had

more points including one which stood at 20/20!. The rationale was that Tom Morfett in the course of studying the torsional constant discovered that the elastic limit had been exceeded and hysteresis had set in. He choose to make an in-depth investigation of this unexpected phenomenon instead of following the guidelines set by the question paper. The work was original and in the spirit of creative research.

The Awards Presentation and Closing Ceremony was held the next evening on July 26. We watched with great pride as our students received their medals. The five special prizes out of which one went to our student Suvrat Raju, was handed out by Prof. Carlo Rubbia, the **Nobel Laureate**. After the ceremony we had the honour of being personally congratulated on our team's performance by Prof. (Ms.) Elena Sassi who had constructed the problem on electro-magnetism and the **Noble Laureate** Prof. Carlo Rubbia.

Postscript

In summary, the performance of our students was creditable. That is not to say that we can be complacent. Generally, the students at our training camp are strong in theory. Their scores in theory ranged from 26.5/30 to 28.2/30, altogether a fine performance. However, scaling arguments, visualization skills and the use of symmetry in solving intricate physics problems do not form part of their repertoire. These we need to stress, apart from those parts of the Olympiad syllabus which are not covered in their XII Standard syllabus. As mentioned earlier, the discussion in the training camp on the use of symmetry arguments paid handsome dividends in the Olympiad exam. The performance of our students in the experimental component was admittedly poor. In part this is a reflection of our social culture. Parents consider the use of a bicycle pump or the act of fixing a flat tyre as menial and insist that their kids visit the bicycle repair shop rather than "dirty" their hands. Besides, even our better schools have woefully inadequate laboratory facilities. None of our competitive.exams with the sole exception of INPhO have an experimental component. As part of the training camp we were aware of these problems. Over the past two years HBCSE has done considerable work in putting together a physics laboratory of Olympiad standards at its campus. More needs to be done. But the bottom line is that at the training camp we are up against a whole culture and mind set.

Two hundred and ninety-one students from sixty-two nations participated in this event. In addition four nations (including Pakistan) sent observers and will, in all likelihood, participate from next year. In spite of efforts by the international committee, no African nation was represented at the Olympiad. Other notable absentees were France, Greece and Japan. The next Physics Olympiad, the first of the new millennium, will be held from July 8 to July 17, 2000 in Leicester, Great Britain. Over seventy nations are expected to participate.

One was witness to a variety of attitudes at the Olympiad. For some nations it is a war. At the other extreme were people who believed that physics should be ***"fun"***. One of us (VAS) discussed these attitudes with our students. He quoted a famous American baseball coach *"Winning is not everything. It is the only thing!"*. On the other hand he quoted a British poet :

"Nor frame nor honour bade me fight
Nor public men nor cheering crowds
A lonely impulse of delight
Drove to the tumult in the skies."

Unanimously, the students expressed their preference for the latter attitude.

The Olympiad is not just an international competitive exam of exceptional difficulty. It is a celebration of physics: the thrill of making advanced/modern concepts in physics accessible to young minds via carefully crafted problems; the joy of perusing problems rich in historical flavour; the bonding and sharing with young students of over sixty nations; the empathy evoked when one meets kindred delegation leaders deeply committed to physics educatio, all this made our relentless efforts worthwhile.

Acknowledgment:

We wish to thank Arvind Kumar (HBCSE), H.C. Pradhan (HBCSE), Sunil Datta (BARC) and R.N. Kapoor (IAPT) with whom we have had many useful and enjoyable discussions. Rajesh Khaparde and his youthful team displayed admirable patience while explaining the nuances of the experimental set-ups at HBCSE. Finally, we would be guilty of a great injustice if we did not acknowledge the staff at HBCSE, particularly Sumana and Gajanan.

References:

1. Prof. R.M. Dharker was the delegation leader and Prof. Vijay A. Singh was the pedagogical leader of the Indian team.

2. H.C. Pradhan, *The 29th International Physics Olympiad,* Physics News **29**, 151 (1998).

3. H.C. Pradhan, *Report on the First National Physics Olympiad and the 29th International Physics Olympiad,* Resonance **4**, 104 (1999).

4. *Proceedings XXIX International Physics Olympiad,* edited by V. Augustsson (XXIX International Physics Olympiad Committee, Taeknigardor, Dunhagi, 5 Iceland, 1998).

5. V.A. Singh, *The XXX International Physics Olympiad Examination 1999,* Bulletin of the Indian Association of Physics Teachers **16**, 278 (1999). (A detailed listing of the problems will be found in this journal).

Abbreviations and Acronyms

HBCSE - The Homi Bhabha Center for Science Education [National Center set up by TIFR in Mumbai]

IAPT - The Indian Association of Physics Teachers [A voluntary, grassroots organization of Physics Teachers active for over 15 years]

IIT - The Indian Institute of Technology

INPhO - The Indian National Physics Olympiad (Exam) [An annual national level examination conducted jointly by HBCSE and IAPT]

IPhO - The International Physics Olympiad (Exam) [An annual examination in which sixty-two nations participated this year at Padua, Italy.]

JEE - The Joint Entrance Examination [An annual entry level national examination conducted by the IITs]

TIFR - The Tata Institute of Fundamental Research [A premier research body situated in Mumbai]