International mathematical olympiads and India

The month of July this year brought some happy and exciting news to the mathematical community in India. The team representing India at the 39th International Mathematical Olympiad, held at Taipei, Taiwan, performed magnificently, winning 3 gold and 3 silver medals. It is a record success, far surpassing any of our earlier results. In terms of performance of the team as a whole, India ranked 7th among the 76 participating countries, as against our earlier performances at around the 15th rank. Aptly, the team was accorded heroes' welcome on their return, and was greeted personally by the Honorable Minister for Human Resource Development, Murali Manohar Joshi, R. Chidambaram, Chairman, Atomic Energy Commission and Secretary, DAE, and V. S. Ramamurthy, Secretary, DST.

The International Mathematical Olympiad (IMO) is an annual event which began in 1959 with seven participating countries, hosted by Romania, and is becoming more and more popular with every passing year. Initially the participation was limited to the east European countries. In the seventies, several Western countries entered the fray. Many Asian countries joined the IMO in the eighties, including China and Iran in 1988 and India in 1989. Among our neighbours, Sri Lanka is taking part for the last three years and Bangladesh has now expressed interest in participating in the IMO. Over the years the number of participating countries has grown ten-fold.

Several Asian countries have also hosted the IMO, in the last decade. The 37th Olympiad, in 1996, was hosted by India, in Mumbai, and it is perhaps no coincidence that a notable record has been achieved within two years of the event.

The IMOs are held in a different country each year, the choice of the venue being made from the proposals to host the event. The main feature of the olympiad is a competition for individual students under 20 years of age, who have had no formal exposure to mathematics at the university level. Each participating country is invited to send a team of up to 6 students for the contest. The contest consists of 6 problems, in two groups of 3 each on two days, a duration of four-and-a-half hours being allotted per day. The students take the tests individually, to compete for the gold, silver and bronze medals.

Each team is accompanied by a leader and a deputy leader, both of whom are mathematicians. Leaders of all countries together form the jury, chaired by the host country, and are in charge of selecting the problems for the contest. The problems are selected by the jury from a short-list of about thirty problems prepared by the host country. The short-list itself is prepared out of the problem proposals sent in earlier by the participating countries. The solutions to the problems given by the students in a team are first evaluated by the leader and deputy leader, and then in consultation with a coordinating committee from the host country awarded points between 0 and 7. Award of a medal to a contestant depends on the total number of the points scored, in the six questions together. The cut-off scores for the award of gold, silver and bronze medals depend on the total number of participants and are decided by the jury. Special prizes are also considered for striking solutions of individual problems.

At the 39th Olympiad at Taipei, the Indian team consisted of Chetan Balwe (Pune), Abhinav Kumar (Jamshedpur), Soham Mazumdar (Ranchi), Hariharan Narayanan (Mumbai), Rishi Raj (Ranchi) and N. V. Tejaswi (Bangalore), with Shailesh A. Shirali, Rishi Valley School, as the leader and the present author as the deputy leader. The cut-off levels for the medals were 31, 24 and 14 respectively, out of a total possible score of 42. From the Indian team, Abhinav Kumar scored 32 and Chetan Balwe and N. V. Tejaswi scored 31, bringing the three gold medals. Rishi Raj got a silver medal with a score of 30, missing the gold by one point. The other two team members Soham Mazumdar and N. Hariharan scored 26 and 24 respectively, bringing two more silver medals.

There is no formal system of ranking the countries by the performance of their teams. A system of unofficial ranking has been in vogue, taking into account the total scores of the teams and the tally of medals. The first ten ranks at Taipei were held by Iran (211, 5-1-0), Bulgaria (195, 3-3-0), Hungary (186, 4-2-0), USA (186, 3-3-0), Taiwan (184, 3-2-1), Russia (175, 2-3-1), India (174, 3-3-0), Ukraine (166, 1-3-2), Vietnam (158, 1-3-2), Yugoslavia (156, 0-5-0) and Romania (155, 3-0-2). (China, which has frequently topped the list, did not participate this time due to political reasons.)

Landmark

The superior performance in IMO-98 promises to be a landmark in mathematical developments in our country. Pursuit of mathematics as a creative activity has of course been an integral part of our culture, just as music, literature and other forms of art. Mathematical problems like puzzles are found in many of our old texts. For instance, in *Ganita Sara Sangraha* of Mahaviracharya (9th century AD) and *Leelavati* of Bhaskaracharya (12th century AD) mathematics and poetry meet in a charming manner, as nice and challenging problems are rendered in the form of beautiful verses. It is heartening that our young people are also showing great aptitude and interest in mathematics, furthering the ancient tradition.

While India began participating in the IMO only in 1989, the olympiad activity itself, albeit in a local form, goes back at least to the sixties, when late P. L. Bhatnagar, Indian Institute of Science, had undertaken it, mainly around Bangalore, to enthuse students into mathematics. Similar activity also existed in Gujarat. In 1986 the National Board for Higher Mathematics (NBHM), the body set up by the Department of Atomic Energy for promotion of higher mathematics, undertook the responsibility of coordinating the efforts in various regions and organizing an olympiad contest at the national level. Since then the activity has grown and has come of age in many ways. The initiative and efforts put in towards this end by late Izhar Husain, Aligarh Muslim University, may be specially mentioned in this context. Since 1986 Indian National Mathematical Olympiad tests are conducted every year. There are Regional Mathematical Olympiads (RMOs) in various geographically demarcated regions and winners of the RMOs appear for the INMO. A team of 6 students for the IMO is selected from the INMO contest.

The NBHM has set up a permanent Mathematics Olympiad Cell, which is functioning from the Department of Mathematics, Indian Institute of Science, Bangalore, and consists of some expert teachers, to oversee the Olympiad activity in India. The INMO is followed by a four-week training camp for the 30-odd toppers, starting sometime in May, organized by the MO Cell with the help of volunteers from around the country. So far, the training camp has been held either at the Indian Institute of Science, Bangalore, or at the Homi Bhabha Centre for Science Education, Mumbai. The MO Cell also produces written material useful for aspiring mathematical olympians.

The efforts have paid good dividends. Since 1989 our teams have bagged a total of 5 gold, 27 silver and 21 bronze medals. Young people are turning up in greater numbers for various training programmes for the Olympiads.

India's future at the IMO

The results of this year highlight also the importance of organized effort and training, rather than dependence on pure raw talent. For the first time in the ten years of our participation in the IMO, we had a very experienced team who had gone through three/two years of our training programme. The junior batch (the INMO-98 batch) which did not find a representative in the IMO team this year may perhaps have a lot to contribute next year; and we may also look forward to further achievements by Rishi Raj, who has one more chance (the other winners of this year have completed 12th standard or equivalent and will not be eligible for the contest next year).

It also seems worthwhile to make the following observations: the cumulative experience has been that geometry is a strong point of Indian competitors; usually our team members come up with novel, off-beat solutions and sweep all the points for the geometry problems. On the other hand, combinatorics seems to be our bugbear and this is where we have to improve in order to better our performance in the IMO.

In terms of participation in the IMO, in addition to sending trained and talented teams of students, we could also contribute questions. Finding a challenging problem (which nevertheless has a reasonable chance of being solved at least by the best young brains around!) is also a highly creative and difficult task. The problems proposed have to 'compete' with other proposals, in their merit as challenging and interesting problems. So far, in the ten years of our participation, three problems proposed by the training-faculty members were selected for the final contest; one each in 1990, 1992 and 1998.

While it is important to participate in the IMO movement and win laurels, it is certainly not to be viewed as an end in itself. A major need of our times is to enrich the mathematical culture, both in terms of research contributions of the highest level and to raise the general awareness and familiarity among a wide range of professionals, and young people with mathematical talent have a major role to play in this respect. The NBHM has followed this perspective and strives also to nurture the talent located through the Olympiad activity to achieve this objective, to the extent possible. The NBHM awards scholarships to about 30 leading students from each batch of the INMO if they choose to pursue mathematics for their undergraduate degree or if they enroll for a training programme in mathematics conducted by the NBHM, which can be undertaken concurrently to other regular courses that they may choose to join. The latter involves distance training during the working part of the academic year coupled with courses in the summer organized at some of the established centers of mathematics, for each batch. Over the years this has produced some fruitful results, which would however be premature to try and quantify.

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RESEARCH NEWS

A new model for promoting protein crystallization in solution

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Efficient crystallization of folded proteins from solutions is essential for three dimensional structure determination of the proteins. It is, however, not easy to grow large single crystals of proteins. In the absence of any microscopic understanding of protein crystallization, the growing of protein crystals has remained more of an art than science[1].

In an article entitled 'Crystallization of Macromolecules: General Principles', Alexander McPherson wrote: 'In principle, the crystallization of a protein, nucleic acid, or virus is little different than the crystallization of conventional small molecules. It requires the gradual creation of a supersaturated solution of the macromolecule and follows the spontaneous growth centres or nuclei'[2]. Several recent studies, however, have questioned this age-old wisdom that crystallization of proteins is essentially the same as of small molecules and instead suggested that the kinetics of crystallization of proteins and colloids can indeed be *very different* from the crystallization of small molecules[3,4].

What are the factors that inhibit growth of single crystals? First, of course, is the fact that proteins tend to aggregate and precipitate if the conditions are not correct. This has formed a vicious cycle because we need high concentration of proteins so that the critical nucleus required to start crystal growth can form. Second, there is always the possibility of the formation of poly-crystals which can happen if multiple nucleation sites are present in the solution.

The way to facilitate the growth of