

# THE 50th INTERNATIONAL MATHEMATICAL OLYMPIAD

## Official report by the Luxembourg team

*If this be method, there is madness in it.* (adapted from Shakespeare's *Hamlet*)

In mid-July 2009, Germany hosted the fiftieth International Mathematical Olympiad (or IMO for initiates), the world championship of secondary school mathematics. Bremen welcomed 565 contestants from 104 countries, who were to engage in a challenging competition in the chivalrous fight for shiny metal – a formulation which uninspired speakers often uncritically embrace.

At the IMO 2009, Luxembourg was represented by a team of six contestants, led by leader Charles Leytem (LUX7) and deputy leader Ming-Koon Hsu (LUX8). Gruesome photographs of the contestants can be found at the official internet site of the IMO<sup>1</sup>. The IMO is an individual competition, but a ranking of nations is published and carefully scrutinised by team leaders. As some happily point out, Luxembourg has held for many years the position of the leading Grand-Duchy. In 2009, Luxembourg ranked 60th among 104 competing countries and won three bronze medals as well as one Honourable Mention (awarded to those contestants who do not get a medal, but solve one problem completely). The Luxembourg performances were

		P1	P2	P3	P4	P5	P6		
LUX1	Pierre Haas	7	7	0	1	0	0	15	Bronze Medal
LUX2	Jérôme Urhausen	0	0	0	0	0	0	0	
LUX3	Jingran Lin	7	7	1	1	0	2	18	Bronze Medal
LUX4	Philippe Schram	4	4	0	0	1	0	9	
LUX5	Marc Sinner	0	7	0	5	2	0	14	Bronze Medal
LUX6	Grégoire Genest	7	0	0	1	1	0	9	Honourable Mention

This was the first time ever Luxembourg took part in an IMO with a complete team of six contestants. As often happens, we were relegated to the last place in the Benelux by a convincing margin.

## For whom the BEL tolls

It has been remarked upon that some contestants study advanced topics known to be trivialising difficult problems of the past, the *combinatorial Nullstellensatz* ranking among the more popular, not only to tackle difficult problems, but also to impress their peers and hence vanquish their competitive insecurities. Alas, solving IMO problems requires mathematical knowledge, which, though not necessarily constituting very advanced mathematics, is carefully obviated by secondary schooling. Prospective Luxembourg contestants, chosen among the younger laureates of the Belgian (or more accurately, Walloon) Mathematical Olympiad (OMB), therefore undergo the Walloon IMO preparation, consisting of several weekends a year in the *Domaine de la Marlagne*, placed in a forlorn spot amongst the forests of the Ardennes. The architecture of the place has doubtless been born of the remodelling of the plans for a World War II bunker and the complex would have pleased King Minos. A final preparation session, in which the other (Flemish) half of the Belgian team took also part, completed the preparation. Given the inevitable communicative issues (or, as LUX5, prone to considering himself above political correctness, mischievously put it, the fact that it is difficult to tell Flemish from a throat inflammation), we witnessed some interesting language struggles. Any resemblance to Umberto Eco's Salvatore in *The Name of the Rose* is purely fortuitous.

The AML, the Association of Luxembourg Mathematicians, is anxious to organize trainings in Luxembourg, too. In 2009, three such events took place in Mersch, known to international readers as the venue of one of the *Ersatz*-IMOs of 1980. Aware of my notorious inability to use a compass on a blackboard, I preferred to make an approximate drawing, which accounted for some very interesting results in the geometry of potatoes. Quoting obscure geometric lemmas when solving a problem is with hindsight not a very good idea. Other team members will vouch for the truth in that matter. A very interesting geometry problem required

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<sup>1</sup>At <http://www.imo-official.org>, the interested reader may find virtually any information on the International Mathematical Olympiad, including explanations of some jargon used in this report. In case the intellect craves after something beyond sobre statistics of results, reports on the conduct of previous IMOs can be retrieved from <http://www.imo-register.org.uk/reports.html>. These are not indicated in case of total lack of humour.

dissecting a quadrilateral into four triangles and, having used a couple of homotheties, gluing them together into a parallelogram. Despite the fact that this problem was rated difficult by any standard, solving it at an IMO using that method seems to present two major drawbacks: (i) the impossibility of making an exact figure given that the problem involved an obscure sum-of-angles-condition and (ii) the fact that scissors appear not to be allowed at an IMO.

Continuity was assured at the more or less official ceremony during which the Luxembourg IMO team was presented, with that particularly inquisitive journalist making us adopt the same peculiar square pose for the team photograph. The quality of the photograph however mirrored the quality of the brief article, interspersed with gruesome factual inconsistencies, which was to appear later in a Luxembourg newspaper. This put an end to our beliefs that journalists are mostly concerned with reporting facts. After we had settled on LUX2 as the interview victim, we concentrated on raiding the quite excellent buffet. LUX4 successfully illustrated his own interpretation of the greedy algorithm, which involved blocking the door so as to intercept each plate and thus securing a gargantuan share of the manifold titbits. Communism does not appear to be an acceptable option for mathematicians-to-be.

## When shall we three meet again?

The year 2009, saw also, in somewhat ponderous parlance, the advent of a new mathematics competition. Indeed, in order to foster contacts among young mathematicians in the Benelux countries and to rehearse for IMO 2011 (but not necessarily in that order), the Netherlands hosted the first Benelux Mathematical Olympiad (shortened to BxMO, presumably an attempt to attract public interest by means of a superficial similarity to a BMX competition) in May 2009. Thirty contestants from Belgium, the Netherlands and Luxembourg convened in Bergen op Zoom, near the Belgian border, Luxembourg being represented by a team of ten contestants, led by leader Charles Leytem, deputy leader Bernard Felten, and third leader (alternatively styled *maître-nageur*) Pascal Dupont. The Luxembourg contestants won three bronze medals. Though the organisers had planned to award an Honourable Mention to any contestant who does not get a medal, but solves one problem completely, the results were such that any contestant who had solved one problem completely was also awarded a medal. We were relegated to the last place in the unofficial ranking of countries by a quite sizable margin. The contest's difficulty was however mirrored by a rather low mean score of less than 9 out of 28 marks. It is worth mentioning that one contestant from the Netherlands managed to get a perfect score<sup>2</sup>.

The Luxembourg team was selected on the basis of its performance in the semi-final of the *Olympiade Mathématique Belge* and in the *American Invitational Mathematics Examination* (AIME), with the latter being multiplied by ten for the purposes of the qualifying score (which was, somewhat characteristically for mathematicians, determined by adding the two scores up with a Microsoft product).

Surprisingly, the whole Luxembourg team managed to turn up at Luxembourg railway station, despite the fact that this was, until the very last second, subject to some doubts, as one participant had chosen to adopt a more than liberal interpretation of the meeting time. In Arlon, we were joined by Belgian leader Philippe Niederkorn, who had repeatedly pointed out that originating from the southernmost point of Belgium was a sufficient reason to rely on other team members' abilities at speaking Flemish. The train journey was

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<sup>2</sup>The problems of the First Benelux Mathematical Olympiad were:

**Problem 1.** Determine all functions from the set of positive integers to the set of the squares of the positive integers that satisfy  $f(m+n) = f(m) + f(n) + 2mn$  for all positive integers  $m$  and  $n$ .

**Problem 2.** Let  $n$  be a positive integer and let  $k$  be an odd positive integer. Moreover, let  $a$ ,  $b$ , and  $c$  be integers (not necessarily positive) satisfying the equations  $a^n + kb = b^n + kc = c^n + ka$ . Prove that  $a = b = c$ .

**Problem 3.** Let  $n$  and  $r$  be integers such that  $1 \leq r \leq n$ . In town  $X$ , there are  $n$  girls and  $n$  boys, and each girl knows each boy. In town  $Y$ , there are  $n$  girls  $g_1, g_2, \dots, g_n$ , and  $2n-1$  boys  $b_1, b_2, \dots, b_{2n-1}$ . For  $i = 1, 2, \dots, n$ , the girl  $g_i$  knows the boys  $b_1, b_2, \dots, b_{2i-1}$  and no others. In both towns, a party will be held where  $r$  girls from that town and  $r$  boys from the same town are supposed to dance with each other, forming  $r$  dancing pairs, each girl only dancing with a boy whom she knows. Denote by  $X(r)$  and  $Y(r)$  the number of ways in which such dancing pairs can be chosen in towns  $X$  and  $Y$ , respectively. Prove that  $X(r) = Y(r)$ .

**Problem 4.** Given a trapezoid  $ABCD$  with parallel sides  $AB$  and  $CD$ , let  $E$  be a point on the line  $BC$  outside  $[BC]$ , such that the segments  $[AE]$  and  $[CD]$  have a common point. Assume that there exists a point  $F$  inside segment  $[AD]$  such that  $\angle EAD = \angle CBF$ . Denote by  $I$  and  $J$  the intersections of  $CD$  and  $EF$ , and  $AB$  and  $EF$ , respectively. Let  $K$  be the midpoint of segment  $[EF]$  and assume that  $K$  is different from  $I$  and  $J$ . Prove that  $K$  belongs to the circumcircle of triangle  $ABI$  if and only if  $K$  belongs to the circumcircle of triangle  $CDJ$ .

somewhat lengthy, which accounted for our late arrival and an exhilarating incident: third leader Pascal Dupont had poured on his salad a liberal quantity of what he believed to be some kind of mustard vinaigrette, but which in fact turned out to be melted vanilla ice cream. Notwithstanding the disparaging remarks uttered about the food at the training sessions, it appears that the bizarre concoctions at the *Domaine de la Marlagne* provided adequate preparation for such culinary mishappenings. At least, Pascal Dupont faced the situation with a very English stiff upper lip – in spite of him not being an Englishman. The next day, having sat the four-and-half-hour exam, consisting of four problems, we happily converged to a swimming pool. This revealed the purpose of the Third Leader. Meanwhile, the leaders and deputy leaders were left to ponder on the chthonic elucubrations written in the style of James Joyce’s *Finnegans Wake* (in the words of Martin Amis ‘a six-hundred-page crossword clue, the answer to which is *the*’) behind which contestants at mathematical olympiads disguise (partially) correct mathematics. Later that day, as I walked past the coordination rooms, I beheld our leader, who was explaining a script which he held half a centimetre before his eyes. I supposed rightly that he was coordinating the third problem, a combinatorics question, to which I had handed in but rough work with ample arrows to guide the reader. This offended the coordinators, who deducted two marks. This cost me the silver medal (which I missed by one mark) and accounted for our leader’s sour mood as well as some of his slightly patronising remarks about the coordinators, the more so as my nearly complete solution to the last problem (which in fact only lacked some straightforward computation) was awarded but a single mark. In the evening, the organisers held a ‘discussing the problems’-session. Some contestants, including myself, had previously declared that they would not attend this discussion round. Somewhat characteristically, I was however unable to refrain myself from making ample comments. Some people would presumably have liked to shove a verbal Imodium into my mouth, or, alternatively, award me the Golden Microphone. The contestant later known as BEL5 was unhappy, for we were not interested in his horrifying induction to prove an equally horrendous identity involving factorials. The next day, after the awards ceremony, marked by a certain number of speeches, we set off for the return journey, accompanied by LUX5’s learned comments on the Dutch railway system as well as the train station of Antwerp.

## An IMO diary

*This lengthy diary is loosely based on reality: while this diary cannot be called a work of fiction, some details owe their appearance rather to the author desperately wanting to deliver some poor punchlines than to them actually having happened at the IMO. Caveat emptor.*

**Monday, 13th July** – The IMO journey began for the contestants at the not-so-new, not-so-shiny railway station of Luxembourg<sup>3</sup>, which, despite an ambitious renovation programme, still contributes to conveying a justifiedly seedy image to its immediate and not-so-immediate vicinity. Once the immediate concerns, namely heaving our suitcases into the appropriate compartments above our heads, had been more or less effectively dealt with without any apparent damage to LUX4’s spine, LUX5 distributed the team polo. We learnt that LUX6’s German was restricted to the one sentence ‘*Du bist eine große Katastrophe.*’, which, admittedly, is of limited use when it comes to ordering an ice-cream. This offended LUX2, who has German roots, but a rather loud, somewhat cacophonous rendering of the Luxembourg national anthem brought him back down to earth. Thankfully, the Ministry of Education had clearly anticipated such musical wonts and agreed to us travelling first class in small compartments. After changing trains in Cologne, we arrived in Bremen, where we were eventually met by our guide, Friedrich Feuerstein, himself a former IMO contestant for Germany. Accommodation within the precincts of *Jacobs University Bremen* was to prove above the slighting epithets which I had hitherto deemed appropriate for IMO accommodation. Nonetheless, I should perhaps point out that those people who slept in camp beds may have a different opinion. During a dinner which definitively jeopardised the favourable opinion I had formed so far on that part of the IMO, Friedrich, after casting a great many wary glances about the surroundings, conspiratorially enquired whether LUX3 was indeed an autist. It gradually transpired that he had spoken to Giancarlo Kerg, last year’s LUX2 (though I should like to insist that he categorically denies having made comments to that effect). A lecture on the IMO

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<sup>3</sup>In order to understand the subtleties of this diary, the interested reader is invited to consult last year’s diary on the conduct of the Forty-Ninth International Mathematical Olympiad in Madrid, Spain, which expatiates upon the various mishappenings that occurred during that IMO. In order to reach a synthesis (a term very popular with those who do not understand it), the author will strive to draw comparisons between these two olympiads.

programme and the various human weaknesses (most notably bringing a protractor into the examination room, but more about this *Geodreieck-Skandal*, as UNK7 eloquently put it, later), which contestants are supposedly prone to fall prey to by Chief Invigilator and Chief Organiser Dierk Schleicher (wearing a unique double-sided badge in fetching blue and brown), rounded the day off. Dark yellow print on beige background is not readily decipherable. The Belgian team arrived much later in the evening, owing to a train engine failure or such-like, on which LUX5, somewhat characteristically, made ample comments. I have rarely seen Belgian deputy leader Philippe Niederkorn (BEL8) so agitated. Come to think of it, he seemed nearly as exasperated as when he commented on the quite disastrous results on the geometry questions in the two team selection tests.

**Tuesday, 14th July** – The venue for this year’s opening ceremony appeared to be an industrial unit converted into a fashionable concert hall. The logistics of access to sanitary installations proved inadequate, and the fact that there was but a single set of toilets proved a serious drawback. Though an organiser was present to cordon off access to the toilets for either leaders or students, this person had clearly not anticipated the possibility of some leaders still being inside the toilets when students were already allowed access. On the cultural side, the opening ceremony boasted a dubious break-dance performance (yielding unwelcome flashbacks to the screeching girlie-band at the IMO 2007) and a finger-calculating performance by Albrecht Beutelsbacher, which was slightly less of a success. A photographer who was definitively not prone to vertigo managed to squeeze all the contestants into a single photograph, having realised that the one and only way to capture the attention of such a crowd was to provide sufficient evidence of imminent bloodshed by standing on a narrow rail some five meters above the ground. Catering in form of dubious packed lunches illustrated proverbial German efficiency seriously backfiring. We learnt later, much to our amusement, that some leaders had not been able to resist the temptation of a packed lunch, so that, when the contestants’ cohort attacked the terrified employees of the catering company, there was a serious shortage of lunch packets. In the afternoon, after we had waited for one hour and a half at the wrong spot, we found the photographer who made the team photographs. Upon return from a city tour paired with dinner in a very good restaurant, we had our pre-contest briefing with our guide, during which we learnt that not only protractors, but also set squares were considered *personae non gratae* in the contest room. It seems an attractive prospect to forbid the use of pencils during the contest. At least, this would considerably shorten the coordination period. LUX5 was angered by the flooding which the Australian contestant with whom he and LUX2 were sharing a bathroom had caused when he had taken a shower. LUX5 declared his intention of lecturing that poor Australian bloke on the subtleties of using a shower, that is telling him to close the door.

**Wednesday, 15th July** – The first contest day started some ten minutes late, for many contestants were still queuing up in front of the insufficient sanitary facilities when the contest should already have started. The attempt of Chief Invigilator Dierk Schleicher to emulate IMOAB chair József Pelikán, the epitome of multilingualism, who habitually delivers part of his opening address in the language of the host country, was an utter failure, for the French instructions were barely intelligible and those in Russian (another official language of the IMO) caused much roaring laughter among East European contestants. An embarrassing grammatical mistake on the verso of the answer paper definitively discredited the translator. The problems of the first day were, in this order, number theory, geometry, and algebra<sup>4</sup>. The setting of the geometry problem lacked an Oxford comma and we later learnt that the first problem was originally formulated in an obfuscated combinatorialish way. It was about members of a society giving each other presents according to a certain rule. The problem then asked to prove that it was impossible that someone was given a present of

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<sup>4</sup>The problems of the first day of the Fiftieth International Mathematical Olympiad were:

**Problem 1.** Let  $n$  be a positive integer and let  $a_1, a_2, a_3, \dots, a_k$ , where  $k \geq 2$ , be positive integers in the set  $\{1; 2; \dots; n\}$  such that  $n$  divides  $a_i(a_{i+1} - 1)$  for  $i = 1, \dots, k - 1$ . Prove that  $n$  does not divide  $a_k(a_1 - 1)$ .

**Problem 2.** Let  $ABC$  be a triangle with circumcentre  $O$ . The points  $P$  and  $Q$  are interior points of the sides  $[CA]$  and  $[AB]$ , respectively. Let  $K, L, M$  be the midpoints of the segments  $[BP]$ ,  $[CQ]$ , and  $[PQ]$ , respectively, and let  $\Gamma$  be the circle passing through  $K, L$ , and  $M$ . Suppose that the line  $PQ$  is tangent to the circle  $\Gamma$ . Prove that  $OP = OQ$ .

**Problem 3.** Suppose that  $s_1, s_2, s_3, \dots$  is a strictly increasing sequence of positive integers such that the subsequences  $s_{s_1}, s_{s_2}, s_{s_3}, \dots$  and  $s_{s_1+1}, s_{s_2+1}, s_{s_3+1}, \dots$  are both arithmetic progressions. Prove that the sequence  $s_1, s_2, s_3, \dots$  is itself an arithmetic progression.

which he had already made a present to another member of the society. In its online edition, the German magazine *Der Spiegel* pointed out that the problem was given to contestants in the above abstract version to avoid confusion and translation issues. I believe that the original version was simply slightly stupid. During the contest, I was slightly disconcerted by some rhythmic beatings behind me, and reached the conclusion that the prize for incommensurable weirdness definitively went to a contestant who spent half an hour with drumming on his forehead. Later that day, over a game of Uno or such-like, I quoted the Luxembourg drinking song *Kättche, Kättche breng mer nach e Pättchen*. LUX5 pointed out that his father always changed this to *Gréitche Gréitche breng mer nach e Bréitchen*. I immediately devised lyrics to go with that line, ‘immediately’ being very obviously a gross exaggeration, for it took me quite some time to write the subsequent twaddle down. The result, convincingly devoid of sense, is the new IMO song of the Luxembourg team.

### D’Rieslingspaschtéitchen

Mier iessen an de friemen Länner,  
 Vill Zorte Brouder schwaarz a wäiss,  
 Si gi gesicht vu ville Kenner,  
 Vun hei bis déi Säit vu Paräis,  
 Mier iessen d’Rieslingspaschtéitchen,  
 Dat ass d’Paschtéitchen fier onst Land,  
 Si mecht och bal guer keng Téitschen,  
 A schmaacht och schons dem klengste Kand.

*Refrain:* Gréitche, Gréitche, breng mer nach e Bréitchen,  
 Vun dem Bäcker a soss keent,  
 Ei wéi schmaacht mer déi Paschtéitchen,  
 D’ass e Genoss fier d’Nuesebeen.

**Thursday, 16th July** – The second contest day was even more uneventful than the first, for guides had been told of the location of further sanitary facilities, which reduced the seemingly inevitable queue. The problems of the second day were, in this order, geometry, algebra, and combinatorics<sup>5</sup>. After four and a half hours, my script was a complete traffic accident, but I was somewhat relieved to hear that other team members had handed in similar rubbish. Our gruesome performance put an end to our hopes of setting an all-time record for total score and medal count. For some reason, the awkward duty of confessing our mathematical sins to LUX7, who had just informed the Luxembourg press by telephone of his hopes for two silver medals, as well as two bronze medals, was pressed (in the literal sense of the word) upon me. Later, as we beheld FRA7 briefing his team with big gestures, we convinced ourselves that other teams had, on this second day, slightly underperformed, too. An Austrian contestant, who will not be named, had suffered an asthma fit as the result of an allergy, thitherto unbeknown to him, to the peanuts he had greedily ingested during the contest, but, in true olympic spirit, he managed to convince the paramedics that, despite his visibly shaky condition, he was alright and should thus be allowed to continue writing the contest. The computer facilities at IMO 2009 were somewhat neolithic, being not only terribly slow, but also terribly prone to blue-screens and other pathologies more commonly associated with the DOS systems used in the olden days. This did not impair contestants who were desperate enough to convey their learnedness by posting manifold Latin quotations in an Internet forum.

<sup>5</sup>The problems of the second day of the Fiftieth International Mathematical Olympiad were:

**Problem 4.** Let  $ABC$  be a triangle with  $AB = AC$ . The angle bisectors of  $\angle CAB$  and  $\angle ABC$  meet the sides  $BC$  and  $CA$  at  $D$  and  $E$ , respectively. Let  $K$  be the incentre of triangle  $ADC$ . Suppose that  $\angle BEK = 45^\circ$ . Find all possible values of  $\angle CAB$ .

**Problem 5.** Determine all functions  $f$  from the set of positive integers to the set of positive integers such that, for all positive integers  $a$  and  $b$ , there exists a non-degenerate triangle (that is, a triangle with non-collinear vertices) with sides of lengths

$$a, f(b), \text{ and } f(b + f(a) - 1)$$

**Problem 6.** Let  $a_1, a_2, \dots, a_n$  be distinct integers and let  $M$  be a set of  $n-1$  positive integers not containing  $s = a_1 + a_2 + \dots + a_n$ . A grasshopper is to jump along the real axis, starting at the point 0 and making  $n$  jumps to the right with lengths  $a_1, a_2, \dots, a_n$  in some order. Prove that the order can be chosen in such a way that the grasshopper never lands on any point in  $M$ .

**Friday, 17th July** – Our first IMO excursion took us to Papenburg, to the *Meyer-Werft*, an impressive shipyard, which, again, epitomises German efficiency. Instead of building the shipyard next to the sea, the Founding Fathers of the *Meyer-Werft* convinced themselves that it would be far more interesting to build ships some kilometres upcountry, which requires highly delicate fluvial navigation via the narrow Ems into the North Sea. The visitors' centre of the *Meyer-Werft* had clearly anticipated the arrival of a large gathering of somewhat potty mathematicians by installing 'staircase' panels immediately next to the staircase. Due to budget limitations, the programme scheduled a visit to the *Tunxendorfer Waldsee* afterwards. According to our guide, this destination had, somewhat characteristically for mathematicians, been determined by planting a compass onto a map and drawing a circle centered at the *Meyer-Werft*, and subsequent use of *Google Earth* to find cheap amusement. Unfortunately, the weather prospects were rather bleak, which resulted in our senior guide exclaiming that 'the place does not look very beautiful'. Accordingly, via some streets definitively inadequate for large buses, we returned to Bremen, sadly without having spotted the lake. Our arrival was delayed by sightseeing of the more spectacular aspects of the Bremen rushhour and the traffic jams that it entails. A traffic sign warning road users that a particular spot was susceptible to accidents involving a red car crashing into the back of a black car held our attention. Rather loud performances of various songs by the German and Dutch teams accompanied the bus journey, the Germans trying to thwart any Dutch song with '*Ohne Holland fahr'n wir zur WM*'. This illustrates the fact that mathematicians, anxious to doff the image of the mathematical hermit, go to any lengths to prove that they are rounded human beings. At least, I feel convinced that the bus driver, who had found a sympathetic ear for his repeated dronings on how Bremen's road infrastructure had changed since the end of World War II in the person of our senior guide, could not tell us mathematicians apart from a bunch of inebriate hooligans. Other contestants underwent a different programme with excursions to Hamburg or Bremerhaven.

**Saturday, 18th July** – On Saturday morning, we visited the *Schlachte*, a flea market, presumably in order to contemplate a plethora of jumble and cheap bric-à-brac. Again other contestants underwent a different programme. The BEL's went to a swimming pool, with BEL2 illustrating how not to jump off a ten metre diving board. A video of the performance is available upon request. Having successfully resisted the temptation of purchasing a set of half-broken knives, we set off for the station. On our way, we thoroughly examined a polyhedral sculpture. The acrobatic performance of LUX2 and our guide on the sculpture's plinth resulted in us being granted some frowning looks by passers-by and allowed us to reach the conclusion that the sculpture shows a skew octahedron with some of its edges removed. In the afternoon, and early evening, we all gathered for a barbecue to contemplate plates piling higher and higher next to LUX4. By that time, coordination was almost complete, but the organisers' decision of randomly hiding the score on a single problem for each contestant made speculation about medal boundaries difficult. Our own estimations still proved far more accurate than those found on MathLinks. LUX3 managed a stunning coup by scoring two marks on the extremely difficult last problem. In fact, her solution was almost complete, but linguistic shortcomings lost her some marks. In the evening, we recorded a game of Monopoly to immortalise LUX5's acerbic dronings against LUX2, his high-pitched outcry when he learned the price of Park Lane with two houses, and LUX4's bowel-upsetting recollection of his nutritional intake at the barbecue.

**Sunday, 19th July** – Once the medal boundaries (14 for bronze, 24 for silver, and 32 for gold) had been published with surprising efficiency on the official internet site of the IMO, some people indulged in a statistical analysis of the results, noting that, for instance, LUX5 was the only medal winner who scored no marks on the first problem. Meanwhile, LUX5 was complaining to everyone who was willing to listen (or not) about the quite extraordinary amount of lavatory paper their Australian neighbour went through, but a quite simple expedient which I had devised, namely giving some of our lavatory paper to LUX2 and LUX5, shut him up and put an end to this scatological discussion. I felt rather pleased with myself for thinking of that solution. The main event of the day was obviously concerned with mathematics rather than shortages of household utilities: the much advertised celebration of the Fiftieth Birthday of the International Mathematical Olympiad. The organisers had invited six prominent mathematicians, most notably the Fields Medal Winner of 2006, Terence Tao, to Bremen to deliver a short lecture. The lecture by French mathematician Jean-Christophe Yoccoz was difficult to follow, not only because of its obscure mathematical content, but

also owing to the fact that it was impossible to understand his English without solid knowledge of French. Towards the end of the ceremony (which some people took as a welcome opportunity to have a nap), the guests of honour were presented with a book. Dierk Schleicher conveyed his need for manual contact by shouting into his microphone 'I want to shake hands, too.'

**Monday, 20th July** – The supposed highlight of the IMO 2009 was the excursion to Wangerooge, a small island tucked away in the Wadden Sea, recently proclaimed as a World Natural Heritage Site by the UNESCO. Three ferries despatched the IMO crowd to the island, where signs had been posted everywhere to direct people to a stretch of the beach which had been reserved for exclusive use by IMO people. Upon arrival, we were completely soaked through and greeted by rather bleak weather prospects. The alternative programme would have shepherded the IMO crowd into a church, presumably so as to allow leaders to illustrate their recollection of the IMO 2005 hurricane night. Fortunately, there was no need for that. LUX2 had his own go at political incorrectness (in the eyes of a senior German citizen; from a more tolerant point of view, it is but a joke worthy of the faintest trace of indignation) when he mused about the possible translation of that injunction any French tour guide uses: '*Suivez le guide.*'. Catering on the island was provided by stout locals (to keep up the illusion of bucolic wilderness which the inhabitants of large cities tend to associate with these small islands). I chose penne with tomato sauce, being convinced that it was impossible to massacre such a simple dish. I was mistaken. In the afternoon, we took part in a Sudoku Scavenger Hunt across the island. The most difficult task was strangely not to solve the problems, but to find former German contestant Georg Schröter to whom we were meant to communicate the code word (which turned out to be the *Mathematigerin*, the German mascot). Later, we took a walk round the island, which we readily reduced after LUX4 had discovered that I had been considering distances modulo two kilometres. Taking a cross-country shortcut (unfortunately slightly overgrown and boasting vicious thorns), we returned to the station, where a group of islanders in appropriate attire were already belting out a large sample of not-so-well-known shanties. LUX5 was evidently much more interested in the island's small railway line. As we set off, Dierk Schleicher communicated his goodbyes to Wangerooge by megaphone, whilst LUX3 showed off her card tricks and her ability to solve some configurations of a  $7 \times 7 \times 7$  rubicube (the very probable misspelling revealing that I am not even capable of solving a  $3 \times 3 \times 3$  cube). Aboard the return ferry, over the statutory packed lunch, we noticed that LUX6 was missing. The search was hindered by the fact that, in order to boost his Mister-IMO-campaign, LUX6 had dressed up as a woman with the help of the Tunisian guide, presumably wanting to win the Miss-IMO-election, too. Much to our dismay, we learnt on the return journey that LUX6 was leading in the Mister-IMO-election, but we were somewhat reassured when the German guide declared her willingness to emulate the Iranian Council of Guardians.

**Tuesday, 21st July** – The closing ceremony boasted a diverse cultural programme. It seems in retrospect much more likely that the organisers were simply at a loss when it came to answering the question how to entertain the dignitaries and authorities present. The result was a mixture of Beethoven, an excerpt from a musical and a quite spectacular physics show. LUX4, always prone to lewd innuendoes, definitely misconstrued a certain remark. FRA4 accepted his medal clad in an IMO banner which the French team had, somewhat illicitly, acquired during a cloak-and-dagger operation which thwarted our plans to take the same banner with us. The medal feast went smoothly along as long as the main presenter of the show was busy handing out (bronze) medals himself. Unlike the bloke who had quite passably announced the bronze medal winners, this master of ceremonies had definitively not rehearsed the list of medal winners. Some decidedly classy and impressive names from the Far East proved a stumbling block, to the same extent as the subtleties of politics, when he eloquently announced the medal winners from the *United Kingdom of England*. He was immersed in his ponderous dronings which, in the end, amounted to very little but congratulating people for existing, to such an extent that he did not notice that some gold medal winners had not yet received their medals when he asked them to leave the stage, as they had bizarrely been listening to the aforementioned idle banter in lieu of accepting their medals. After Kazakstan had presented the IMO 2010 teaser (which featured a very effective manner of dealing with time-consuming speeches) and the IMO party started to break up, LUX3, LUX5 and I took place next to the entrance so as to intercept the rest of the team by agitating the Luxembourg flag. Our efforts were however vain, for the organisers had learnt surprisingly quickly from the

issue that had arisen earlier when but two doors were open. Accordingly, as we stood waiting for the rest of the team next to the door, they had already gathered in the foyer. Leaving the German team to be interviewed by various TV chains (decidedly, GER6 was becoming so famous that people were no longer saying that she had an Angela-Merkel-hairstyle, but that the German chancellor had a Lisa-Sauermann-hairstyle), we left for lunch. The prospect of a packed lunch after the closing ceremony had offended LUX8, somewhat of a gastronomy fan, who, accordingly, took as via a photo session with the *Bremer Stadtmusikanten*, to a restaurant. LUX5 suggested hanging our medals onto the *Bremer Stadtmusikanten*. I sensibly pointed out that we were one medal short, which LUX7 took as an opportunity to blame LUX4. In the afternoon, after I had distributed the problem folders, which LUX8 had got rid off by dumping them onto my bed, CAN1 set me a geometry challenge, inviting me consider a point  $P$  inside a triangle  $ABC$ , such that  $P$  lies on the internal bisector of  $\angle BAC$ . I leave proving in an elementary way that  $BD = CE$  (where  $D$  and  $E$  are the intersections of  $AB$  and  $AC$  with the parallels to  $BP$  and  $CP$  through  $C$  and  $B$ , respectively) as a challenge to the reader. During the farewell party, some blunt idiots were definitively unable to find the end of the queue, but I managed to convince the catering lady not to serve them anything. As for the Mister-IMO-election, electoral fraud took the form of an unannounced final, which, alas, LUX6 tragically lost. The ceremonious awarding of the *Microphone d'or* to the most communicative leader is an unmistakable sign that an IMO is drawing to its close. This year, UNK7, who had earlier – quite poetically – paraphrased LUX8's intention to go to a bar by noting that they would be led to a far distant land where happiness is to be found, had not been in control of his jaw muscles and accordingly received the award. Later, LUX7 did some dancing and LUX8, having offered chocolates to virtually anybody, seemed offended by my inertia when it comes to dancing. After a regrettable incident involving my hand and an alarm switch on a door, we, that is LUXes and BELs, were forced to relocate our game of *Loup-Garou* to another college. We also learnt that LUX2 was really good at emulating Louis Armstrong, whilst LUX4 had obviously been impressed by the IMO song, and illustrated his own version of its refrain (which would make any Spaniard wince) by ample gestures which involved arm-crossing in order to symbolise elementary mathematical operations.

**Wednesday, 22nd July** – After what appeared a ridiculously short night, we left the campus of Jacobs University for Bremen railway station, where we bid farewell to LUX8. Next came the traditional postcard ordeal. Unfortunately, other teams seemed to have had the same idea, for there was a severe lack of stamps, so that we could but send three postcards. A complimentary pack of *Mozartkugeln* which we were offered by the Austrian team, presumably yielding much wailing and gnashing of teeth in any dietitian, constituted the backbone of our food on the lengthy train journey home, apart from an over-priced, flabby sandwich purchased in the *BordBistro*. The fact that our Scrabble scores have risen with the years mirrors our gradually refined cheating techniques, though we have agreed not to trespass the limits of decency, nor – as far as geography is concerned – a wobbly line south of Stuttgart, the latter ukase having been edicted by LUX4, who had been offended by LUX5's GÄU, an area in southern Germany. Some people display a certain propensity at quoting obscure Chinese dynasties when it comes to getting rid of Q's. Sadly, my excellent suggestion of KÖPFENIQ (which, I argued, is the way a dyslexic would spell the *Hauptmann von Köpenick*, a German impostor of the nineteenth century buried in Luxembourg), totalling at over ninety points, was not taken up. LUX4 however managed a stunning coup with STOCKIRE (the German idiom to denote a typical Irishman), totalling at nearly two hundred points, despite LUX2's repeatedly pointing out that he was rather stretching the limits of the German language. I took the opportunity to deliver a rant against other team members' limited vocabulary, as they tried to prevent me from using the noun KEFIR (a fermented milk drink from the Caucasus). I successfully thwarted this attempted coup by pointing out that, after all, the game belonged to me. At Luxembourg railway station, where LUX7 had to dash off lest he missed his connection, we swapped some idle banter before splitting up and setting off home.

Throughout the IMO, a Luxembourg newspaper took a lively interest in the Luxembourg performances and published two articles, the result of a telephone conversation with LUX7. The telephone line must have been crackly, for, in the article, the trip to Wangerooze was turned into a trip to Wernigerode, a small nest in the Harz, a mountainous region in central Germany. The Luxembourg Hall of Fame, as it appeared in the article, constituted an excellent example of unreflected use of a popular shortcut involving the CTRL-key:



the journalist had failed to notice that *Jingran Lin* and *Lin Jingran* were very obviously one and the same person. Moreover, printing the Hall of Fame in reverse alphabetical order was a rather peculiar choice.

So, that was IMO 2009. While writing this report, it occurred to me that this was my last IMO. Memories aplenty crop up, lasting and pleasant memories shared by the members of the Luxembourg team and the rest of that huge IMO family. There are too many things which I did not write about, like that small Luxembourg flag, drawn last year by LUX4 to commemorate that unexpected feat by the Luxembourg football team, namely defeating Belarus. I cannot think of any appropriate highbrow valediction to a fantastic Fiftieth International Mathematical Olympiad, but I would like to thank those people who officiated as *avocatos diaboli* (not avocados, mind you) when it came to correcting my grammar and spelling. Any residual mistakes are entirely their fault.