目　录

中国数学的现状和未来

CONTENTS

The Present and Future of Mathematics in China

中国数学的现状和未来

丘成桐

（哈佛大学/清华大学）

改革开放已经超过 40 年了，在中央政府的英明领导下，中国人民安居乐业，享受着太平盛世。多年来，中国人民胼手胝足，完成了大量的基础建设，取得了伟大的成就，在多方面超出了西方国家的想象，也因此引发西方国家的恐惧。他们担心中国的兴起会威胁到他们。尽管这远离事实，但是他们开始从各个方面压制中国。这五年来的国际形势对中国不利。但是我想，大多数人都会承认，未来十年是中国崛起至为关键的十年。在西方合围中国的情况下，我们必须走出一条突围自强之路。毫无疑问的是，中国必须在科技上成为强国。我们必须掌握这些科技的根源，也就是我们所说的基础科学。不仅要掌握，还要发展出新的方向，带动科技潮流，才能领先世界。

基础科学多姿多彩，但是基础科学中的基础是数学科学和理论物理。而数学既是物理学的基础，也是一切工程理论的基础！所以任何一个强大的现代化国家，数学的成就必须名列前茅！

1　中国与世界数学发展

1.1　中国数学发展历史

我们现在来看中国数学的发展历史。在中国魏晋南北朝以前，中国数学在世界古文明中，不算差，以应用为主，只是远不如希腊。隋唐至宋朝末年，欧洲处于黑暗时代，阿拉伯国家的数学有一定发展，中国数学某些方面比西方进步，但是从世界数学历史来看优势并不显著。到了明朝中叶以后，西方文艺复兴，数学科学的发展势不可挡，中国数学开始大幅落后于西方。直至清末，中国数学家才开始认识微积分和复数运算，落后西方超出了 250 年之久！而这 250 年却占据了人类数学史上最辉煌的大部分时间。要追上，并不容易。

1.2　世界数学发展概况

1.2.1　欧洲数学

英国数学大盛于牛顿（Isaac Newton），牛顿之后转入低沉，大约 80 年后，于 19 世纪初实现复兴，直到当代。

法国数学始于费马(Pierre de Fermat)、笛卡尔(René Descartes)等人,历久不衰。二人创立了数学上的很多不同方向,影响了数学研究几百年。至今,法国数学还是走在世界最前沿。

德国数学始于莱布尼茨(Gottfried Wilhelm Leibniz)。17 世纪中叶之后,德国数学大师屡现,而到了 18、19 世纪,已经领导西方数学。莱布尼茨之后,高斯(G. C. F. Gauss)、黎曼(G. F. B. Riemann)、希尔伯特(D. Hilbert)等一大批伟大的数学家在德国涌现。但由于两次世界大战,德国数学家远走异国他乡,德国数学出现衰落。可是深厚的科学文化底蕴还在,到了 1950 年,德国又再次成为一个重要的数学国度。

当前中国数学和这些老牌数学大国仍然相差甚远。

1.2.2 美国数学

为了发展数学,美国从 1880 年开始派留学生到欧洲。在那以前,美国没有学术研究可言,大学的主要任务是教学,哈佛大学亦是如此。一位英国数学家西尔威斯特(James Joseph Sylvester)到访约翰霍普金斯大学,敦促他们花功夫做研究,美国大学重教学轻科研的境况才逐渐改变。哈佛大学、芝加哥大学、耶鲁大学很快开始发展科学,而他们做的第一件事就是派学生到德国、法国、英国留学。到了 1910 年,在伯克霍夫(George David Birkhoff)的领导下,美国数学研究开始有了突破。伯克霍夫解决了一个划时代的问题,他关于有限制条件三体问题的著名研究,是庞加莱去世前就想解决的重要问题。他代表了新一代完全在美国受教育的学者,促使美国数学家获得心理上的突破。在伯克霍夫领导下的哈佛大学,出现一大批重要的研究突破。根据美国数学学会的统计,伯克霍夫的门徒加起来差不多有万余人,散布于美国各地。他们之中有 4 位伟大数学家开创了新的学派,包括引入莫尔斯理论的马斯顿·莫尔斯(Marston Morse);近代拓扑学的创始人哈斯勒·惠特尼(Hassler Whitney);偏微分方程现代非线性理论的创始人莫里(Charles B. Morrey)和 Morrey 的学生——美国概率论创始人杜布(Joseph Doob)。同时,美国利用两次世界大战的机会,大量吸收欧洲的数学家。到了 1960 年,美国数学已经领导世界。

中国现今数学还没有达到美国 20 世纪 40 年代的水平。

如何比较两个国家在某一段时间的数学成就?我认为,要看同一段时间内,两个国家分别诞生了多少足以影响世界数学 50 年甚至更长久的学术成就。19 世纪 40 年代,美国数学科学涌现十多个甚至几十个伟大的学术成果。而中国数学,包括华裔学者在内,虽然在这一百多年来努力追赶,仍然只有几个学术成就能够达到这样的水平。这是我们必须更加努力的原因。

1.2.3 俄罗斯数学

俄罗斯的数学历史始于 18 世纪,欧拉(Leonhard Euler)受邀来到俄罗斯,当时伯努利兄

弟也正在圣彼得堡皇家学院深耕。俄罗斯数学真正生根要到19世纪初期至中叶，出现了罗巴切夫斯基(Nikolas Ivanovich Lobachevsky)、切比雪夫(Pafnuty Lvovich Chebyshev)，从分析、几何、概率论出发，改变了俄罗斯数学的面貌。到了20世纪中叶，已经可以和美国抗衡了。苏联解体以后，经济不景气，大量学者移居美国和欧洲，不复往日辉煌。虽然如此，俄罗斯科学院仍然有大批世界一流学者，新生一代也有不错的数学家，俄罗斯数学势力还是不可小觑。

1.2.4 日本数学

日本和我国文化比较接近。明治维新时期，派了不少学者到英国、法国、德国留学。最重要的学者叫高木贞治(Teiji Takagi)，他在19世纪末到德国哥廷根大学跟随一代大师希尔伯特(David Hilbert)学习。1900年，他回到日本后，开始改革日本的教学方法，撰写了不少教科书。到了1915年，他在数论方向做出了极为重要的突破性工作，推广了希尔伯特提出的类域论(Class Field Theory)，开创了崭新的研究方向。他的研究介绍到德国之后，引起很大反响，又由埃米尔·阿廷(Emil Artin)等数学家进一步发展，成为数论的一个重要潮流。高木贞治的成就使得日本数学家信心大增，认为日本人也可以在本土做世界第一流的工作。

到了1940年代末期，日本人在世界数学界已经出人头地，出现了差不多十来个影响世界的数学家。第一个是小平邦彦(Kunihiko Kodaira)、第二个是广中平佑(Hironaka Heisuke)、第三个是森重文(Shigefumi Mori)，还有岩泽健吉(Kenkichi Iwasawa)、志村五郎(Goro Shimura)、佐藤干夫(Mikio Satō)、冈洁(Kiyoshi Oka)等，这些都不是普通的数学家，而是开创了一个学科、足以改变世界数学发展的数学家。最突出的一个是伊藤清(Kiyosi Ito)，他在1938年的博士论文中引进了随机微分方程，影响了20世纪概率论的发展。

我们需要注意的是，这几个国家发展出来的数学代表了近代数学的大部分成就。几乎没有例外，每个国家数学的兴起都有一个重要的带领学者，其在数学上的工作能够影响学坛百年之久！比如牛顿之于英国、高斯之于德国、费马和笛卡尔之于法国、伯克霍夫之于美国、高木贞治之于日本。这些学者为本国数学学科的发展注入了信心，带领年轻人向前走，这是很重要的经验。

中国数学还没有达到这个成就，尚未出现改变世界数学发展、领先全球的重要方向、领域和学科。

1.3 中国数学发展的关键时刻

在中国，谈到当代最重要的数学大师，毫无疑问，当属陈省身(Chern Shiing-Shen，1911—2004)先生。陈先生是20世纪最伟大的数学家。他在1945年发表的文章，提出了

规范场或纤维丛最重要的结构，其影响直到今天，差不多 80 年了。陈先生 1946 年从普林斯顿高等研究院回国后，带出了一批杰出的中国数学家。几年后，他去了美国，在美国也带出了一批华裔数学家，我也是他的学生。直到 19 世纪 80 年代中叶，陈先生全面回国。那时候，他已经七十多岁了，培养出的学生大部分留学海外，想要复刻 40 年代风貌，有很大困难。当时国内经济积弱，也是一个重要原因。陈先生晚年全部时间都期望能够在中国培养出大数学家，更盼望中国成为数学强国，这是他的梦想，我期望能够继续他的事业。

1979 年我第一次踏入北京，到各地走了一下，真是一穷二白，无论建设和人才都和西方有很大的距离。邓小平同志做了个英明的决断，派大量留学生到美国、欧洲学习，并且引入资金投入到科技。四十多年来，不少留学生、访问学者回国，本土培养的大量学生也成长为了优秀人才。建设国家，上下同心，中国终于崛起。

但是今天中国之形势，外部强敌环伺，无理打压，科技被卡脖，正如诸葛亮说的“此诚危急存亡之秋也”。

2 亟待建立新的评价指标

一个国家数学的真正兴起，不在于有能力去萧规曹随，跟着其他国家的学者做一些修补工作，而在于自己走出一个重要的科研方向，其他国家的学者就会有浓厚的兴趣来跟随学习。到目前为止，中国数学的水平未达后面的地步，却也超过前述的水平。未来这三年是中国崛起的关键时刻，达不到国际上最前沿的地步，恐怕引进的学者都会逐渐离开，前功尽弃！这不是危言耸听，因为现在有能力的学者到中国来，也还是希望在世界数学舞台上占一席之地。中国没有办法提供这样的学术环境的话，他们恐怕会选择离开。

2.1 中国现有学术评价体系存在不足

评价一个大学或一个国家的数学内容必须要有一个公平的评审系统。我们要达到和国际同行平起平坐，很重要的一环是知彼知己！

但是直到目前为止，中国数学界对我们国家的数学水平处在世界前沿什么位置并没有搞清楚。一般来说，中国评估奖项、评估晋升，较少征求国际专家的意见，大部分意见由国内的一些同行来决定。但是现代数学多姿多彩，可以分出几十门不同的方向。而中国数学学科大部分重要学者年纪偏大，往往因循守旧，对于现代数学发展的认识并不全面，他们对一些新兴学科不了解，评估亦不够准确。

在这样的背景下，很多前沿领域的研究人员遭受打击，年轻的学者不得已选择因循守旧，没有能力、没有兴趣去走一条自己的路，也逐渐和世界前沿的发展脱了轨。

即使是国际评估，很多学校都是以论文多少、影响因子高低等来做决定。这样的方法对于一般学问还算可靠，但是对于最前沿的学问却是远远不够的。

十年前我看到一个新闻，台湾交通大学的工科被评为世界第一，近年来我也听说清华大学的工科也是被评为世界第一。大家都十分高兴，但是大家心里知道，麻省理工学院、斯坦福大学、加州大学伯克利分校等名校的工科比这两所大学强，他们不断发表领导世界的论文和发展工业最前沿的技术，而我们中国名校还鲜少这样的突破性科研成果。

从这点看，我们明白通过机器找寻影响因子用来评估学科是否达到世界一流的方法，并不客观，达不到评估的目标！美国的名校，如哈佛大学、麻省理工学院、斯坦福大学、普林斯顿大学、加州大学伯克利分校等都有世界一流的学者，他们自己对前沿的学问有深入的了解，再加上同行评审（peer review），很清楚自己的水平。一般来说，他们不会公开他们的意见。而中国高校既缺乏最前沿科学家，又较少征求全球专家的意见；即使征求，也多局限于华裔学者，那就很不全面了。

2.2 前沿科学奖可作为评价体系改革的标杆

我是如何判断中国数学的成就的呢？从 1979 年，我第一次踏上北京的土地，直到现在，我每年都会回到中国，无论是内地、香港还是台湾，平均起来，每年总有几个月的时间，而到我任教的美国大学学习的中国访问学者和学生也是为数不少。这十多年来，我门下弟子回国的也不是小数，包括了两个影响深远的院士。到如今，我也在中国建立了 8 个以上的数学研究所。我自己做的学问，也横跨基础数学、应用数学和理论物理，因此对中国数学的情况还是有一定的了解。但即使如此，我对中国数学的了解直到今年才更深入。

2022 年，中国科协的领导来清华大学和我见面，希望我带领中国数学在国际上走出一条自己的路。在北京市政府支持下，我和清华大学数学科学中心、北京雁栖湖应用数学研究院的同事们筹备并举办首届国际基础科学大会[①]，邀请了全世界在数学、理论物理、理论计算机与信息科学上有重要贡献的学者齐集北京，讨论最前沿的学问。

我们设立了一个极为重要的国际奖项——前沿科学奖。我们将数学、理论物理、理论计算机与信息科学领域分为 34 个方向。每个方向找到大约 5 位该领域最活跃的专家进行评审，他们分别来自英国、法国、德国、美国、俄罗斯、以色列、日本、印度等国。

① 首届国际基础科学大会（The International Congress of Basic Science）于 2023 年 7 月 16—28 日在北京举行。这一国际顶级学术盛会，聚集八百余名中外科学家，吸引四百余名学生参与，举行五百余场学术报告，另有十余场专题活动，联动北京、上海、南京、香港四地卫星会议，贡献了一场知识的接力、思想的碰撞。大会主题为“聚焦基础科学，引领人类未来”，倡导科学探索、开放合作，为中国基础科学领域注入了新活力，为推动科技领域国际合作打开了新大门，为拓展科学边界贡献了中国智慧。

我们邀请的评委中有 4 位菲尔兹奖得主、1 位诺贝尔奖得主、4 位图灵奖得主，54 位欧美各国院士，56 位国际基础学科领域重要学会会士，百人次获得世界级大奖，全部约 190 位大学者。由这些学者一起评估，选出过去 5 年发表的最佳论文。这些论文应该能够准确代表数学发展的方向，而且获奖者也是实至名归的。

我们邀请的 190 位评委经过一个多月来日以继夜的讨论，在数学学科中选出了 110 篇近五年来最杰出的论文。为了客观和公平，我们又成立了一个由 30 多位杰出学者组成的复审委员会，最后挑选了 86 篇最佳论文。全世界最权威的专家参与整个评审过程，十分严谨，我相信是最具公信力的评审过程！

3 对中国数学发展的思考

3.1 认识中国数学的真实水平

可以说，前沿科学奖的评审结果让我十分惊讶！在数学领域 86 篇获奖论文中，只有 6 篇是国内大学教授的作品，其余都是海外大学教授作为作者（不少论文有超过三位作者）的论文！所有涉及评选的会议和讨论都由中国大学教授担任召集人，歧视中国学者的可能性不大。前沿科学奖的评选结果可以用来作为中国数学和世界数学前沿比较的客观指标，它具说服力地反映了国内数学的真实水平。

结合前沿科学奖评奖结果，再比较国内很多重要奖项的评奖结果，可以清晰地看出，国内现有的评估没有“真实”地把中国学者的学术水平展示出来。比如，很多在国内得到重要奖项的学者们的成果并没有入选，这说明他们的研究成果没有进入世界数学的最前列，没有得到国际同行的普遍认可。

3.2 华裔学者获奖值得深思

这次评选结果显示了一个值得注意的现象：署名是华裔作者的论文虽不及欧美学者数量之多，有 20 篇入选，表现也算不错了，但这些学者大部分并不在国内。除了前面提到的 6 篇国内数学家的论文外，只有一两位华裔作者最近回到祖国工作。这个现象是值得我们花时间去反思的。

第一件值得讨论的事情是，这十年来，中国经济崛起，虽然个人财富还比不上美国，但是国内杰出学者得到的薪酬和房子的资助已经超过了大部分美国的教授，深圳、上海、杭州等地方都有极为丰富的奖励。听说浙江省有个“鲲鹏行动”计划，提供几千万人民币的天文数字！有好几位数学家因此受益。但是让人遗憾的是，这些奖项的获奖者并不是上述五篇得奖论文的作者。

另外一个问题是，为什么华裔学者在美国名校可以做出最前沿的学问，在中国名校却有困难。

即使在海外的华裔学者，这四十年来的工作，除了张益唐关于孪生素数的著名工作以

外，和当年陈省身先生在微分几何以及周炜良先生(Chow Wei-Liang)在代数几何上的重要性工作是无可比拟的！

不能说海外华裔数学学者的志向就一定单纯，他们中的不少人也被中国“帽子”包围、被中国院士的荣耀引诱，不愿意力争上游。他们的工作和陈省身先生的工作相比，实在难以相提并论！

3.3 注重物质奖励是问题根源

我对这个问题思考了很久，得出的结论是：中国诱导学者做学问的方法太过注重物质的奖励，没有照顾到学问内容本身的水平。我们有大量的优青、青千、杰青等奖励方式，很多高校规定他们只给这些有“帽子”的学者提供丰厚的薪水及住房津贴，因此所有年轻的学者为了“帽子”而拼命！由于缺少国际上特别杰出专家的评估，大家对于学者在科学上的成就，不是夸大其词，就是言不及义！年轻人不敢去做最前沿的学问，因为部分评委不懂这些前沿学问，也怀抱私心，怕这些前沿学问在中国流行以后，他们自己没有一席之地！

3.4 鼓励年轻人明确做学问的目标

鼓励大学和年轻人建立明显的目标，这是极度需要的。我希望在未来十年，包括清华、北大、复旦，至少有十间大学成为世界一流大学。而年轻人的志气必须改进，至少有一小批的年轻学子有志气成为世界一流的学者，做出突破性的工作，能够在学术界引领风骚，影响数学未来几十年的发展！

我们不能够让我们的年轻人一生的志愿就是拿政府颁发的“帽子”，做个院士，甚至得到诺贝尔奖。做学问的目标是要找到大自然的奥秘，找到一切有意义的规律！

4 对中国数学发展的一些建议

4.1 把握机会打破封锁

中国改革开放的政策极为成功，这是有目共睹的事情！但是历史告诉我们，马上得天下，不能够马上治之。况且世界形势在不停地改变，列强对于中国的崛起，可以说是又爱又恨。多国政府通过不同手段迫使学者远离中国，妄图削弱中国的科技实力，窒碍中国的科技发展。它们将不少学科列为国家机密，一同合围中国，这个态度已经日益明朗。但是，大部分西方学者还是希望从纯学术的观点来和我们交流，中国需要在列强对我们合围还未完成之前，走出一条世界学者们支持的路径。自从 2022 年 9 月我们开始筹备“国际基础科学大会”以来，各国学者态度非常积极。他们很高兴看到中国在经济迅猛发展的同时，能够站出来带领全世界的基础科学的发展，以和平的方式造福人类。

4.2 敢于突破常规探索创新

现在我们遇到的问题是，中国的官员太过讲究公平，不敢担当，没有找到有效的方法来提拔一批有领导能力并有国际水平的学者。听闻当年钱学森(1911—2009)先生刚回国时参加导弹的研究工作，需要一批有能力的专家合作，各地院校的领导坚持不放人。经过周总理协调，才能找到 50 多位科学家合作。政策不能一刀切，特殊情况需要采取一些先进的做法。同时，希望中国高校能够打破藩篱，相互合作。

两年前，中央支持我的想法，特批设立“数学科学领军人才培养计划”，并成立清华大学求真书院训练少年学生，这是有客观原因的。历史上几乎所有的数学大师都是在十三四岁时开始发力的。

盖尔范德(Israel Moiseevich Gelfand)是前苏联数学界一代大师，1978 年首届沃尔夫奖获得者，成功培养了一大批俄罗斯的顶尖数学家。盖尔范德在谈到数学人才培养时认为，对未来顶级职业数学家进行数学专业培养应当从 13～16 岁期间开始。俄罗斯数位获得菲尔兹数学大奖的数学家都是在十三四岁时由名师指点学习而后成功的。作为实践，盖尔范德当年在俄罗斯挑选了 5 个幼童，卡兹丹(David Kazhdan)、伯恩斯坦(Joseph Bernstein)、基里洛夫(Alexandre Kirillov)、金迪金(Simon Gindikin)以及他的儿子谢尔盖·盖尔范德(Sergei Gelfand)。在他亲自教导之下，这五个幼童俱成为数学大师。

再看看美国的例子，美国数学界很多主要的学者来自美国五十多所中学，这些中学的学生都是十三四岁入学，受到极为严格的训练。最后两年使用大学本科的教材，由大学教授水平的老师来教导。

香港回归时，香港教育部门的官员认为学生读书太辛苦，不要花时间去读中国历史和中国语文，结果是香港年轻一代不知有国，遗害至今！

有些人对我们选拔少年人才的做法却不能理解，认为我们违背人才培养规律，坚持认为应该让这些有天分的学生和其他学生一样，到了十七八岁再进入大学。我想，主要看学生的程度和能力。求真书院两年来的实践，可以证实我们的做法是正确的。去年，求真书院大一学生参加了全国性数学比赛——丘赛，竟然拿了金奖，还有两个拿了铜奖。

表 1　2022 年丘成桐大学生数学竞赛部分成绩

姓名	奖项	获奖	年级
***	分析与偏微分方程方向	金奖	大一年级
***	代数、数论与组合方向	铜奖	大一年级
***	代数、数论与组合方向	铜奖	大一年级

不敢推进创新人才培养机制的原因是多方面的，除了人事和利益的原因外，我认为最重要的问题在于没有客观的、可信的评估机制。事实上评审的方法是可以比较公平的，不过需要一个良好的过程罢了。上述的前沿科学奖评选就是个十分清楚、客观的过程。

其实，现在中国很多省市在中央的要求下要发展高科技的产业，但是遇到的第一个大问题就是人才的大量缺乏。我到海南省三亚市多次，遇见的就是这个问题。假如我们提拔一批年轻的学生，很快就能解决关键的人才问题。

4.3 营造良好的学术环境

我们要用最良好的学术环境，吸引世界一流的学者来华工作。所谓良好的学术环境，必须要有浓厚的、前沿的、实质的学术内容，让学者在中国的研究环境下，感觉到兴奋，感觉到他们在这个环境中大有可为，可以解决学术上悬而未决、举世瞩目的大问题！如何打造这样的环境，以中国目前的国力，绝对做得到，也能做得好。

但是，目前的很多政策已经过时，需要大幅度的改变，希望中央大力支持！任何的改革，都会触犯到既得利益者的利益，学术亦是如此。我个人估计，改革会产生重要的积极影响，是可以成功的，但是需要得到中央大力的支持！

4.4 加强顶尖人才本土化培养

大量派留学生出国学习的时代已经过去了，我们面临一个严峻的环境，就如当年“两弹一星”的局面，必须自强。十九世纪五六十年代，中央坚持保护了一批杰出的科学家和工程师，让他们没有顾虑地投入国家最前沿的建设，使得我们在科技方面更上一层楼。同样的道理，在本土培养出一批世界一流的学者是当下科技自强的根本解决办法。我很有信心，中国只要有 5 年的功夫，就会发生很大的变化，并不是想象中需要那么长的时间。5～10 年内，中国就能在本土培养出一批世界一流学者，同时能根本地解决很多重要的数学问题。大家一定要合作，要鼓励年轻学者成长。

清华大学求真书院每年招收 100 名有志于数学科研的杰出学生，希望他们毕业后成为数学学科上的领军人物，出人头地，打破美国在数学学科的垄断地位。

我们聘请了世界一流的学者来教导他们，包括我们全职引入的菲尔兹奖得主考切尔·比尔卡尔(Caucher Birkar)教授。这些知名教授遇到求真书院的优质学生，都十分兴奋；也认为在清华大学良好的环境中，能做好研究。

时至今日，求真书院运作了不到两年，已经培养出来一批世界一流水平的大学生，可以见到国事之可为，我们上下一心，敢教日月换新天！

4.5 推动高质量科普教育

在列强环伺下，国内狭隘、盲目的民族主义特别强烈，这会导致人们看不清楚科学的

走向。历史上有个最为极端的案例，就是清末义和团事件，结果中国惨败，几乎亡国！

我们要教育孩子们基本的科学知识，尤其是基础数学。然而有些媒体因为知识有限，而哗众取宠，可能适得其反！另一个最普遍的现象是，电视节目畅谈科普的时候，选取的内容仍然只是古代或近代中国学者的著作，和现代数学内容关系少得可怜。

中国需要大力推动科普，教育民众。也需要在平实的基础上宣扬中国深厚的文化和成就，让我们的学者有自信心去力争上游！虚假的夸大会产生反效果，必须组织一批真正的专家来推动科普教育。科普也要达到世界一流水平，我们要教育孩子们正确的、前沿的科学知识，让孩子们知道什么是“最好”的科学成就，彻底改变哗众取宠的报道风格。

5 结 语

5.1 危中求机祸中倚福

古人讲“祸兮福之所倚”。西方列强对中国科技的围堵确实制造了危机。若应对不当，会让我们新生的科研团队因被西方封锁而无法获得重要信息，最终在打压下失去信心而解散。但是，在危机中我们也看到了一个可喜的现象：这三年来，很多重要的学者和优秀的留学生开始全职回国。只要政策持续向好，中国在未来几年内就会有大的改变。

清华大学数学科学中心刚成立时，吸纳的都是刚毕业的博士；如今，我们已经成功地引进了五六位资深大教授。这其中最出色的是年轻数学家——菲尔兹奖得主考切尔·比尔卡尔，他已经在清华大学安了家，并且带领着一批求真书院的学生充满干劲地做前沿研究。我们也在继续努力吸引新生一代的年轻学者。经过十余年的努力，清华大学数学学科在全球的排名已经由 2009 年的第 96 位跃升到现在的第 24 位。

5.2 加强布局未来可期

我们仔细分析中国数学的前景：经过二十多年的努力，中国核心数学的研究水平开始追上时代。核心数学包括数论、代数几何、微分几何和表示论。

中国数学的主要研究人员分布在清华大学、北京大学、中国科学院、复旦大学、中国科学技术大学和香港中文大学。其中除了微分几何外，中国学者在这些学科取得的成就仍逊于日本学者，而胜于亚洲各国同行（假如将印度裔的美国数论学家计算在内的话，恐怕中国和印度算是旗鼓相当）。还有一些学科方向，包括分析、微分方程和数学物理等，也是同样的情形。我们有一些学者的成就开始能追上世界水平了，但要有突破、要领先，还做不到，这是很值得鼓舞的一件事，当然还要花很多功夫。

如果政府能够制定有效政策，大力支持这些研究方向，上下一心，那么我们国家数学相关方向就有希望在五到十年后追上欧洲各国，但这一定不会是件容易的事情。组合数学、概率论和统计学则大不如欧美各国，亟待充实！应用数学的发展需要建立在基础数学发展的前提下，并加强与工程的结合。

正如人工智能这个学科，中国学者不少，但是真正有创意的不多，究其原因正是：中国的应用数学家对基础数学没有深入的认识。我们在训练年轻学生时，一定要改正他们的错误观念！必须要有扎实的基础科学的训练，才能发展应用科学，不要倒因为果。

20 世纪最伟大的数学家希尔伯特的墓志铭——“Wir müssen wissen，wir werden wissen”，我译为“我们求真，我们会知道”。

我们做学问，要了解学问，要了解学问的主要精神，这是科学的基本精神，而并非为了拿诺贝尔奖、做院士。还有一句是我从《楚辞》改编过来的——“苟真理之可知，虽九死其何可悔”。

我们追求的是真理，不是荣誉或金钱。有了崇高的志愿以后，所有的学问都会迎刃而解。这是很重要的一个思想。希望我们的年轻人努力！

The Present and Future of Mathematics in China

Yau Shing-Tung

(Harvard University/Tsinghua University)

It has been more than 4 decades since the reform and opening up that turns China into a peaceful and prosperous country. Many great achievements have been made as exemplified by the large amounts of completed infrastructure works thanks to the joint efforts of Chinese people. The next decade shall be a key period to the emergence of China. China has to find a breakthrough and to emerge triumphant independently, which undoubtedly necessitates the endeavour towards developing advanced science and technology whose foundation, namely the basic science, should be fully understood. And then we still need to go further beyond to steer towards some new directions and spearhead the current trend of science and technology so as to lead the world in this field.

Although basic science is a diverse collection, mathematics and theoretical physics always play the role as its core while math is the basis underpinning all the physics and engineering theories. So outstanding achievements in mathematics study is the prerequisite for a strong and modernized country.

1　The Development of Mathematics in China and Beyond

1.1　The Development of Mathematics in Ancient China

Let's first take a look at the history of Chinese mathematics. Before the successive period consisting of the Wei Dynasty (220—266AD), the Jin Dynasty(266—420AD) and the Northern and Southern Dynasties (420—589AD), the Chinese math study, mainly emphasizing practicality of math in real life, was of moderate quality compared to other ancient civilizations but was obviously dwarfed by that of ancient Greece. Then Europe was plagued by the dark era of the Middle Ages and some progress in mathematics was made by the Arabians when China witnessed the vicissitudes from the Sui Dynasty (589—618AD) to the end of the Song Dynasty (960—1279AD). It was in this period that Chinese mathematics outran its Western counterparts in some aspects, but not by a big margin as a whole. After the middle of the Ming Dynasty(1368—1644AD) when the

Western world enjoyed the Renaissance which fueled their mathematical development to gain momentum sweetly, Chinese mathematics began to lag far behind the West. It was not until the end of the Qing Dynasty that Chinese mathematicians started to understand calculus and complex operation, more than 250 years behind the West! The two and a half centuries are included in the part and parcel of the most remarkable period of human history, so it is not easy for China to catch up.

1.2 The Development of Mathematics in Other Countries

1) Mathematics in Europe

The blossom of the British mathematics can be best represented by Isaac Newton's achievements. But after Newton's death, the discipline was trapped in a slump for about 8 decades until the beginning of the 19th century when the development of the British mathematics was revitalized. Since then, the sound momentum has remained to this day.

When it comes to the French mathematics, Pierre de Fermat and René Descartes stand out from all the trailblazers. These two mathematicians pioneered many different new directions and exerted a strong influence on math study for centuries. Consequently, the French mathematics enjoys a long-lasting boom and still leads the world today.

As for German mathematics, Gottfried Wilhelm Leibniz is regarded as the founding father. Other succeeding masters of mathematics in this country mushroomed especially after the middle of the 17th century, such as G. C. F. Gauss, G. F. B. Riemann, D. Hilbert and the like. German mathematics thus led the world in the 18th and the 19th century. However, the two World Wars displaced many German mathematicians from their own country, leading to the downturn of German mathematics. Thanks to the impressive accumulation of science and culture throughout history that hadn't vanished, it didn't take too long for the subject to make its comeback in Germany after 1950, enabling the country to be equipped with advanced mathematics again.

It is admitted that China in this field falls far behind these forerunning European countries with a long and glorious tradition of mathematics.

2) Mathematics in the United States

In order to develop mathematics, the United States in 1880 began to send their students to study in Europe. Before that, there was no academic research whatsoever in the United States, and the main task of their universities was to teach, as was the case at Harvard University. It was only when a British mathematician, James Joseph Sylves-

ter, visited Johns Hopkins University and pressed for more research that the emphasis on teaching rather than research in American universities started to change gradually. Harvard, along with the University of Chicago and Yale, soon began to develop scientific research. And the priority was to send students to study in Germany, France, and England. In 1910, under the leadership of George David Birkhoff, breakthroughs were made in American mathematical research, which can be exemplified by Birkhoff's famous work that marks a milestone by proving Poincaré's "Last Geometric Theorem", a special case of the three body problem. Birkhoff represented a new generation of scholars who got their education entirely in the United States and changed the way that American mathematicians thought of themselves. A large number of important breakthroughs ensued at Harvard under Birkhoff's leadership. According to the American Mathematical Society, Birkhoff's "academic descendants" added up to almost 10,000 and can be found across the United States. Among them were four great mathematicians who pioneered new schools, including Marston Morse, who introduced Morse's Theory; Hassler Whitney, who laid the foundation for modern topology; Charles B. Morrey who stimulated research on general nonlinear elliptic theory throughout the world; Morrey's student, Joseph Doob, the pioneer of American probability theory. At the same time, the United States took advantage of the two world wars by offering shelter and citizenship to numerous European mathematicians. As a result, the American mathematics started to lead the world by 1960.

The mathematics of China today is still nowhere near that of the United States in the 1940s. You may ask, how to compare the mathematical achievements of two countries in a certain period? I think the yardstick is how many relevant academic outcomes they made respectively in the same period of time that can affect global mathematical research for half a century or even longer. Chinese mathematicians, together with foreign mathematicians of Chinese origin, tried their best to narrow the divide for more than a century, but only made a few academic achievements that can equal the outstanding brainchildren of their American counterparts in the 1940s. This is the reason why we must work harder.

3) Mathematics in Russia

The history of Russian mathematics began in the 18th century when Leonhard Euler was invited to Russia while the Bernoulli brothers were also working at the Royal Academy in St. Petersburg. Nikolas Ivanovich Lobachevsky and Pafnuty Lvovich Chebyshev then laid a solid foundation of the Russian mathematics from the 1800s to 1850s by get-

ting down to the analysis, geometry and probability, breathing new life into relevant research. By the middle of the 20th century, the Russian mathematics was on par with that of the United States. But the glory was gone when a large number of Russian mathematicians emigrated to the US and Europe after the collapse of the former Soviet Union together with the economic downturn. For all that, the Russian Academy of Sciences is still an assemblage of a large number of world-class researchers, together with some good mathematicians. So the Russian mathematics cannot be underestimated by any standard.

4) Mathematics in Japan

The Japanese culture shares many similarities with ours. During the Meiji Restoration (from 1868 to the end of the 19th century), Japan sent a lot of native researchers to England, France and Germany. Teiji Takagi was the most outstanding one among them. He went to the University of Göttingen, Germany in the late 19th century to learn from the erudite mathematician David Hilbert. Takagi returned to Japan in 1900 and began to write many textbooks as a way to reform domestic teaching methods. In 1915, he made an important breakthrough in number theory by introducing the Takagi class field theory generalising Hilbert's class field and pioneering a new direction of research. Those studies of Takagi turned out to be inspiring in Germany after being introduced to Europe and then became an indispensable part of number theory after mathematicians like Emil Artin completed some further research based on Takagi's academic outcomes. Takagi's achievements encouraged other Japanese mathematicians to believe that research carried out by native Japanese can be world-class.

By the end of the 1940s, the Japanese had already stood in the hall of fame of global mathematics with dozens of active mathematicians who influenced the world back then, such as Kunihiko Kodaira, Hironaka Heisuke, Shigefumi Mori, and there were also Kenkichi Iwasawa, Goro Shimura, Mikio Satō, Kiyoshi Oka, etc. Mind you, they were not just ordinary mathematicians, but elites who pioneered a direction of study that was enough to change the development of global mathematics. Among them, the most prominent one is Kiyosi Ito who introduced stochastic differential equations in his doctoral thesis published in 1938, which kept its long-lasting impact on the probability theory throughout the 20th century.

Most of the achievements of modern mathematics are made by mathematicians in the above-mentioned countries. It can be spotted that almost without exception, the boom of mathematics in each of these countries was led by an important figure whose

work in mathematics was able to influence the academic community for a century: Newton in Britain, Gauss in Germany, Fermat and Descartes in France, Birkhoff in the United States and Teiji Takagi in Japan. These figures successfully encouraged the development of mathematics in their own countries and guided young researchers to make progress, which is a very helpful experience for China to learn from. But Chinese mathematics today is still waiting for the world-leading subjects, fields or directions of studies that can rise to turn the tide.

1.3 Key Moments in the Development of Mathematics in China

In modern China, the most important math master is no doubt Mr. Shiing-Shen Chern (1911—2004), whom I believe to be the greatest mathematician of the 20th century. His article published in 1945 whereby he proposed the most important mathematical structure of the Gauge Theory, the so-called fibre bundle, which has been influential for almost 8 decades till today. A group of outstanding Chinese mathematicians emerged thanks to the training of Mr. Chern after his return to China from the Institute for Advanced Study at Princeton in 1946. A few years later he went back to the US, where he was later the teacher of a group of Chinese mathematicians studying overseas, including myself. It was not until the mid-1980s that Mr. Chern stopped shuttling between the two countries and began his long residency in China. At that time, he was already in his seventies and most of his successful students took up their abodes abroad. So it was very difficult for Mr. Chern to replicate his fabulous performance in the 1940s. Still China back in 1980s still suffered from the weak domestic economy. In his declining years, Mr. Chern spent all his time in education with two dreams, one of which was that some of his students would be great mathematicians in China someday. Another one, more importantly, was to make China a strong nation excelling at mathematics science. These were his dreams, and I, as his student, look forward to carrying on his lofty causes.

When I first came to Beijing in 1979, I traveled around the country and found out that it was really poor and that there was a startling disparity between China and the West in the quality of both infrastructure and talent. Comrade Deng Xiaoping, the leader of China back then, made a wise decision to send a large number of Chinese students to study in the United States and Europe, together with the endeavour to bring in more investment in science and technology. In the past 4 decades, many foreign students and visiting scholars have returned to China and numerous students at home have been trained to become excellent talents. Our country has finally emerged as a strong power

after all of us work together for a better future of the whole nation.

However, what our country encounters today is that it is surrounded by powerful-competitors. I would like to quote a famous saying of Zhuge Liang, the celebrated adviser and statesman in ancient China, "our very survival is threatened right now".

2 The Urgent Need to Establish New Indicators for Evaluation

If we only know to follow researchers in other countries to bridge some fiddling gaps, the rise of Chinese mathematics will always be a long shot. Instead, it is necessary for Chinese researchers to blaze some new trails of scientific research on their own, so as to attract foreign researchers to follow our study. Although we have not yet been such a leader in mathematics, luckily, we have started to play a bigger role in certain areas. The next three years will be a critical period for China mathematics to be stronger. If we fail to lead the world in mathematics, I am afraid that all the top researchers China has brought in will gradually leave and all the previous successes we have made will be futile! This is not an alarmist prediction, because many capable researchers come to China with the aspiration of staying active on the world stage of mathematics. So if China cannot provide them with a satisfying academic research environment to fulfill their dreams, they may choose to leave.

2.1 Problems in Chinese Existing Academic Evaluation System

It is indispensable for our country to formulate a system for fairly evaluating the mathematics research of a university and a country. A very important way to equal our international counterparts is to know both our competitors and ourselves.

But until now, the Chinese mathematical community has no idea about the quality of Chinese mathematics compared with the global frontier. Generally speaking, when China evaluates the qualifications for certain awards or for promotion, international experts are seldom consulted. Instead, decision-making mainly hinges on domestic peer review. But modern mathematics, with dozens of different directions of academic research, is very complex even for most of the famous active mathematical researchers in China who are somehow challenged by their approaching senility and getting somewhat old-fashioned in passing judgment. Consequently, their understandings of the development of modern mathematics are far from comprehensive and they do not understand some emerging disciplines, resulting in the inaccuracy of their assessment.

Given this background, many researchers in cutting-edge fields got the cold shoulder. Younger generations of the academic community have no choice but to be stuck in a rut, not having the ability or interest to chart a new path of their own, and gradually falling out of tune with the world's frontiers on this subject. Moreover, many domestic universities set their standards of international assessment according to indicators like the number of papers published and the impact factors. Such an evaluation is reliable for only common studies but far from reasonable forthe most cutting-edge ones.

Ten years ago, I read a piece of news that the engineering discipline of the National Chiao Tung University in Taiwan, China was ranked first in the world. I have also heard in recent years that the engineering discipline of Tsinghua University also got the same ranking. Heartened as we are, it was tacitly understood that the engineering departments of the Massachusetts Institute of Technology, Stanford University, and the University of California at Berkeley and the like, are actually stronger than the foregoing two Chinese universities. Besides, these world-renowned foreign universities have continued to publish world-leading theses and develop the most advanced technologies in the industry, whereas such breakthroughs are extremely rare in academic research of influential Chinese universities.

From this point of view, I must say that it is self-defeating to assess whether a discipline is world-class by searching for relevant impact factors through mere machines. Famous universities in the United States, such as Harvard University, Massachusetts Institute of Technology (MIT), Stanford University, Princeton University, University of California, Berkeley and so on, are known for their world-class researchers who have in-depth understanding of themost advanced research in their own sectors and are assisted by justified peer review, so they are very clear about their own situation. But they do not make their opinions public in general. Chinese universities, by contrast, lack domestic academics of front-line science and seldom seek the opinions of foreign experts; even if they do, the sounding board they choose mainly consists of researchers of Chinese descent, which only gets one-sided feedback.

2.2 Suggestions to Take the "Frontiers of Science Award" as a Benchmark for Reforming the Evaluation System

How do I evaluate the achievements of Chinese mathematics? From 1979 when I first set foot in Beijing until now, I pay a visit to somewhere in China every year, be it

the Mainland, Taiwan, or Hong Kong, spending a few months each year in this country on average. I have also seen a large number of Chinese visiting scholars and students come to the United States to learn at the university where I am hired as a professor. Over the past decade or so, not a few of my students have returned to China, including two extraordinary academicians of the Chinese Academy of Sciences. Besides, I have to date established at least eight mathematical institutes in China and my own studies cover basic mathematics, applied mathematics and theoretical physics, so it is fair to say that I come to know about, more or less, the basic situation of Chinese mathematics. But my understanding still appears to be superficial until this year.

In 2022, leaders of the China Association for Science and Technology came to Tsinghua University to meet with me, hoping that I would lead Chinese mathematics to blaze a new trail with global influence. Later, with the support of Beijing Municipality, I, together with my colleagues from Yau Mathematical Sciences Center of Tsinghua University and Beijing Institute of Mathematical Sciences and Applications, hosted the first International Congress of Basic Science[①] where researchers from all over the world who had made important contributions to mathematics, theoretical physics, theoretical computer and information sciences were invited to gather in Beijing to discuss the most cutting-edge science. The Congress witnessed the establishment of a very important international prize called "Frontiers of Science Award". We have divided mathematics, theoretical physics as well as the theoretical computer and information sciences into 34 areas of study and invited for each direction about five of the most active experts from countries like the UK, France, Germany, the US, Russia, Israel, Japan and India to be jury of the competition.

The judges we invited consist of about 190 influential scientists of which over a hundred have won world-renowned prizes of science, including 4 Fields Medalists, 1 Nobel Prize Laureates, 4 Turing Award winners, 54 academicians from Europe and the United States as well as 56 holding fellowships of major international societies in the field of basic disciplines. These scientists worked together to select the best 110 papers published in the past five years. So it can be ensured that these papers can be the epitome of

① The International Congress of Basic Science was hosted from 16—28 July 2023 in Beijing. More than 800 Chinese and foreign scientists, together with more than 400 students attended this international academic event with high visibility where more than 500 academic presentations and dozens of other thematic activities were held, accompanied by parallel sessions in Beijing, Shanghai, Nanjing and Hong Kong. The historical event, with the theme of "Advancing Science for Humanity", marks the first international congress for basic science wholly conceptualized and hosted within China. It aims to provide a robust platform for scholars from all nations to communicate, establish partnerships, and engage in interdisciplinary dialogue, with the ultimate goal of advancing science for the betterment of humanity.

current mathematical development and all the winners of the "Frontiers of Science Award" should be well deserved.

3 Reflections on the Development of Mathematics in China

3.1 The Level of Chinese Mathematics Compared with Its International Counterparts

I have to say that I am very surprised by the results of the competition for the Frontiers of Science Award because only 6 of the 86 papers selected in the field of mathematics are the work of professors from Chinese universities, and the rest were papers written by overseas professors (Many papers were co-written by more than three authors). All meetings and discussions involving the selection are convened by professors from Chinese universities so discrimination against Chinese researchers is unlikely to exist. The results of the competition is a strong evidence of the actual level of Chinese mathematics compared with the world's frontiers.

Comparing the winners of the Frontiers of Science Award with those of major domestic prizes in the same field, it is clear that the academic capability of Chinese researchers cannot be "precisely" revealed by the existing domestic assessments. For example, the papers of many scholars who have been winners of major awards in China have not been selected in the competition for the Frontiers of Science Award this time, which indicates that their research drops behind the global forefront of mathematics and has not gotten general recognition from their international counterparts.

3.2 The Need to Focus on Laureates of Chinese Descent

The results of the competition show another noteworthy phenomenon: 20 papers written by Chinese have been selected, which is not so bad though the number is dwarfed by that of European and American authors. However, most of the authors of these 20 papers are Chinese working abroad. Except for the domestic mathematicians who are the authors of the foregoing 6 papers, only one or two of the rest have recently returned to China. This phenomenon is worth taking time to ponder over.

The truth is, Chinese economy has been booming in the past ten years. Although the personal income per capita is still less than that of the US citizens, outstanding Chinese researchers have already enjoyed salaries and house grants that exceed those of most American professors, and there are extremely rich bounties offered in places such as Shenzhen, Shanghai, and Hangzhou to encourage academic research. I have also been

informed of the "Kunpeng" program of Zhejiang Province that provides talents with tens of millions of RMB yuan and several domestic mathematicians have benefited from it. But unfortunately, none of them were selected by the Frontiers of Science Award this time. Why? This is the first question.

Another question is, why overseas researchers of Chinese descent can carry out cutting-edge scientific studies with fruitful work at prestigious American universities, but have difficulty in doing the same thing at Chinese universities?

Besides, we should never forget that even all the achievements made by overseas researchers of Chinese descent in the past 4 decades, with the exception of Zhang Yitang's influential work on twin primes, cannot match up to the studies finished by Mr. Shiing-Shen Chern in differential geometry and by Mr. Wei-Liang Chow in algebraic geometry.

It is not proper to state that overseas mathematicians of Chinese descent are all driven by sheer aspiration for scientific truth, because many of them are also lured by the honour and title of being a Chinese academician, not willing to strive for excellence. Unfortunately, their achievements are absolutely no match for those of Mr. Chern.

3.3 The Cause of the Problem: the Undue Emphasis on Tangible Rewards

I have reflected on these two questions for a long time and have concluded that relevant decision-makers in China put undue emphasis on tangible rewards for researchers as almost the only way to encourage them to be dedicated to academic activities, thus failing to highlight the scientific significance of a study itself. It is a common practice in the Chinese academic community to pursue academic titles such as National Outstanding Youth (*You Qing*), "The Member of 'A Thousand Young Researchers' Project" (*Qing Qian*), "Distinguished Young Researcher" (*Jie Qing*). The list can go on and on. Universities only provide decent salaries and housing allowances to researchers with those titles which become the only goal that virtually all of the young scientists in China work so hard for. The situation, together with the lack of international assessment by distinguished experts, is the root of the problem that people tend to exaggerate or express dilettante opinions during academic evaluation. Young generations of researchers are afraid of pursuing cutting-edge studies because these studies may be voted down in the application for academic titles as some judges' ignorance of the most recent scientific ideas or concerns that they will be out of date when these studies become popular in China.

3.4 The Requirement for Encouraging Youngsters to Have Clear Goals for Study

A pressing and prominent requirement for China today is to encourage universities and young researchers to be driven by clear goals. I hope that in the next decade, at least ten domestic universities, including Tsinghua, Peking and Fudan University, will become top-notch of their kind in the world. Chinese youngsters must dream bigger, which means that at least a small group of young researchers should have the ambition to be world-class by completing ground-breaking work, becoming front-runners in the global academic community and positively affecting the development of mathematics in the decades to come!

The dreams of our young generation should not be spending their entire lives to get a title granted by the government, nor should they pursue the recognition of being an academician or even a Nobel Prize laureate. Instead, the goal of study and research should always be to reveal the mysteries of Mother Nature and to understand all meaningful laws in the universe!

4 Suggestions for the Development of Chinese Mathematics

4.1 To Seize the Opportunity to Transcend the Predicament

The reform and opening up of China has obviously turned out to be extremely successful, but history tells us that sitting on a throne is much more difficult than winning it, let alone the ever-changing world today. At the moment, most international researchers are happy to communicate with us out of academic interest without any political stand, so China needs to choose a path supported by researchers and to contribute to the world's science community. Since September 2022 when we started to prepare for the International Congress of Basic Science, scientists from all over the world have been very supportive and they are very pleased to witness that China, with its rapid economic development, has finally been able to lead the development of basic sciences around the world to benefit mankind in a peaceful way.

4.2 To Think out of the Box for Exploration and Innovation

The problem now confronting us is that Chinese officials are always haunted by the fear of getting the short end of the stick and dare not assume the responsibility of finding effective ways to promote a group of researchers who show leadership and world-class

capability. Policies cannot impose a simple solution without any better alternative to be fit for special circumstances. Besides, I hope that Chinese universities can stop working in silos and join hands with each other.

Two years ago, the central government supported my idea of setting up a special program for cultivating leading talents in mathematical sciences and establishing the Qiuzhen (meaning "in search of truth" in Chinese) College at Tsinghua University to instruct teenagers because almost all the mathematical masters throughout history started to cut a figure at the age of 13 or 14. I would like to take Israel Moiseevich Gelfand for example. He is a master in mathematics in the former Soviet Union, winner of the first Wolf Prize in 1978 and instructor of a large number of top-level Russian mathematicians. Gelfand believes that the professional training of talents for the goal of turning them into outstanding mathematicians should begin when their ages range from 13 to 16. In fact, several Russian mathematicians who won the Fields Medal started to be instructed by a famous teacher at the age of 13 or 14 exactly. To test his theory, Gelfand selected five young children in Russia, including David Kazhdan, Joseph Bernstein, Alexandre Kirillov, Simon Gindikin, and his son Sergei Gelfand, all of whom finally became masters of mathematics with the guidance of Gelfand.

Let's also have a look at the example of the United States, where the number of domestic high schools from which top-level mathematicians have graduated is more than 50. In these high schools, students are enrolled at the age of 13 or 14 and receive training with extremely rigorous standards. In the last two years of their period of schooling, they start to learn the undergraduate textbooks and are taught by instructors whose expertise is not eclipsed by that of professors in universities.

However, by contrast, after Hong Kong was returned to China in 1997, the officials of the Hong Kong Education Department thought that there was too much burden of study on Hong Kong students and that they didn't need to spend time on the Chinese history and language. The aftereffect of this reckless decision has been impinging on our society for so long that the younger generation of Hong Kong today virtually knows nothing about their motherland!

It is also admitted that some people cannot understand our method of selecting young talents, alleging that we run counter to the law of talent training and that these gifted students should study in universities at the age of 17 or 18, just like other students do. However, I think the age ready for university depends mainly on the ability of students. As a matter of fact, the proven record of Qiuzhen College over the past two

years can confirm that our method is effective. Last year, the freshmen students of Qiuzhen College took part in the S.-T. Yau College Student Mathematics Contest, a national competition. What surprises me is the result that a freshman won a gold medal and two others won bronze medals, as shown in the table following.

Tab. 1 A Part of the Results of S.-T. Yau College Student Mathematics Contest in 2022

Name	Event	Prize	Grade
***	Analysis & Partial Differential Equations	Gold Medal	Freshman
***	Algebra, Number Theory & Combinatorics	Bronze Medal	Freshman
***	Algebra, Number Theory & Combinatorics	Bronze Medal	Freshman

The roots of the fear of further expansion of innovative talent training mechanism are manifold. Apart from concerns over personnel and interest, I think the most important problem lies in the absence of a reasonable and reliable assessment system. The possibility of developing a method for fair evaluation has been proved to exist by the clear and unbiased process for selection in the aforementioned Frontiers of Science Award, as long as the decision-making throughout the whole process is satisfying enough.

Many provinces and cities in China are now trying to develop high-tech industries at the request of the central government, but the first major problem they encounter is the salient lack of talent. It is exactly this problem that plagues Sanya, Hainan Province to which I have visited for many times. If we are determined to nurture a group of young talents, we will soon be able to solve this problem.

4.3 To Create a Favourable Environment for Academic Research

We need to materialize the best conditions that we can offer to attract world-class researchers to work in China. The so-called favourable environment means a home for numerous, cutting-edge and substantive academic achievements so that researchers will feel excited about the condition for academic research in China with the feeling that they can tap a lot of their potential in this environment to solve major academic problems of global interest. The current national strength of China can absolutely create such an environment with flying colors.

But we also need to notice that currently many policies are outdated and drastic changes are required, so I hope that the central government will strongly support this cause! Besides, vested interests can never be untouched in a reform, which is also true

for academics, but I still predict that the reform will have an essential positive impact and will be successful eventually, so I feel compelled to reiterate that, it really needs to be strongly supported by the central government!

4.4 To Strengthen the Cultivation of Top Talents at Home

The era of sending a large number of best students to study abroad has passed. In the 1950s and 1960s, the Central Government insisted on protecting a group of outstanding Chinese scientists and engineers so that they could devote themselves to the most advanced scientific development in their motherland without any concern, thus enabling our country to scale new heights in science and technology. By the same token, a group of world-class Chinese talents in the future is the fundamental solution to scientific and technological self-improvement today. I am very confident that with just five years of hard work, China will make a big difference. Although it is much sooner than someone may have thought, within five to ten years, China will be able to develop researchers with top-tier expertise on this planet and completely solve a lot of important mathematical problems. That's why we must work with collaborative effect and encourage young scholars to make progress.

Every year, Qiuzhen College at Tsinghua University admits one hundred outstanding students who show aspiration for mathematical research, in the hope that they will become leaders in mathematical sciences after graduation and that they will make a name for themselves by changing the global situation that the United States assume complete control of the most advanced knowledge of mathematics.

Consequently, these students are under the guidance of world-leading researchers who have been recruited as outstanding foreign experts, including the Fields Medalist, Professor Caucher Birkar who has taken up a full-time position in our college. These renowned professors were thrilled by the quality of our students and felt that they could finish some meaningful research with the excellent conditions offered by Tsinghua.

Today, after being founded for less than two years, Qiuzhen College has already produced a number of excellent undergraduates who will surely stand out compared to their international peers. Those achievements give us the confidence to make our dreams come true by uniting as one for a rosier picture of our country.

4.5 To Promote High-quality Education of Popular Science

Since our country is currently pressed by international competitors, narrow-minded

and blind nationalism is particularly salient, which will distract people from the path of scientific development. The most famous event in history that we should avoid repeating is the Boxer Rebellion in the late Qing Dynasty, which resulted in such a disastrous defeat of China that the country was then on the brink of being annihilated.

So we need to teach our children about basic science, especially basic maths. But some domestic media assert themselves in a grandstanding way because of their limited knowledge, which may be counterproductive for the education of our country! Another common phenomenon is that when people on TV programs give long-winded speeches about the dissemination of science, what they are talking about is still only the works of Chinese academics in ancient China or in the period from 1840—1949, with virtually no reference to modern mathematical science.

It is imperative for China to actively promote the dissemination of scientific knowledge among the public, together with a moderate way to introduce Chinese profound culture and remarkable achievements without any vaunt, so that our researchers and youngsters can have the self-confidence to strive for excellence. Exaggeration that deviates from the truth will defeat our own purpose. A group of real experts must be called upon to shoulder the responsibility of pressing forward with the education of science. Such an education must also be aligned with the most effective practices around the world. We need to inform our children of correct and cutting-edge scientific knowledge to help them understand what are the "best" scientific achievements rather than being swayed by the press sensationalism.

5 Conclusion

5.1 To Seek Opportunities in Crises

As the old saying goes, "What goes around comes around". Major Western powers try to present hedges around the scientific and technological development of our country, which has indeed created a salient crisis for us. If we do not respond properly, the nascent Chinese teams for scientific research will lose confidence and disband under such suppression. But a silver lining is still in sight that many influential academics and outstanding students who have studied overseas have returned to China for a career over the past three years. As long as China continues to make progress in improving its policies, big changes will be about to happen in this country in the next few years.

When the Yau Mathematical Sciences Center of Tsinghua University was established, the members were all newly graduated PhDs. But today, the Center has man-

aged to bring in at least five senior professors. The aforementioned Fields Medalist Caucher Birkar, who has settled in his new home at Tsinghua University, is the most outstanding one among these professors and is leading a group of students from Qiuzhen College to immerse themselves in the advanced research. Another piece of encouraging news is that, thanks to the hard work over the past decade, the global ranking of the mathematics of Tsinghua University has achieved a leapfrog from 96th in 2009 to 24th now.

5.2 To Formulate Better Plans for a Promising Future

I want to propose a careful analysis of the future development of mathematics in China: after the devoted and painstaking work for more than two decades, the research of core mathematics in China, which includes number theory, algebraic geometry, differential geometry and representation theory, has begun to catch up with the global trend.

Most Chinese mathematics researchers can be found at Tsinghua University, Peking University, the Chinese Academy of Sciences, Fudan University, the University of Science and Technology of China, as well as the Chinese University of Hong Kong. Except for differential geometry, Chinese scientists in these studies of core mathematics are still eclipsed by Japanese, though outperform the rest of their Asian counterparts (that said, I am afraid that Chinese and Indian mathematics are evenly matched if American number theorists of Indian descent are taken into account). It is also the case for other studies pertaining to this discipline like analysis, differential equations, and mathematical physics.

It is encouragingly true that when it comes to scientific achievements, some of our academics has already kept pace with their most excellent international counterparts. However, it is still not yet possible for them to make further breakthroughs and take the lead in the world, which surely requires a long trek with many hurdles to clear.

Painstaking as it will be, if the Chinese government can formulate more effective policies to strongly support these researchers to work together, it will be possible for the core mathematical study of China to catch up with that of European countries in five to ten years. On the other hand, our progress in combinatorics, probability and statistics are lagging behind by the European countries and the US by such a big margin that more complementary endeavors are desperately needed! Moreover, the development of applied mathematics needs to be built on a strong foundation laid by basic mathematics and be integrated with engineering. Otherwise, the consequences will be like the current

situation of domestic artificial intelligence which is delved into by many Chinese scientists without any real creative thinking. Domestic applied mathematicians do not have an in-depth understanding of basic mathematics. Consequently, when we train young Chinese students, we must correct their misconceptions because one must be proficient in basic science before being committed to developing applied science rather than the other way around.

I will end my speech with two aphorisms, the first of which can be foundin the epitaph of David Hilbert, the mathematician widely regarded as the greatest of his kind throughout the 20th century:

"Wir müssen wissen, wir werden wissen."

My translation is: "We have been seeking truth and we will eventually know it." The reason why we choose to be an academic should be to fully understand the essence of what we investigate, which is the spirit of scientific research, rather than to enjoy the vain glory of being a Nobel Prize laureate or an academician.

Another aphorism is my adaptation of a sentence in *Chuci*, one of the best-known compendium of ancient Chinese poetic songs: "If an immutable truth of the universe is discovered, I won't regret it even if I will die for it for many times." I replaced the original text with "If an immutable truth of the universe is discovered" to remind all of us that what we pursue is the truth, not fortune or fame. With this lofty aspiration, there are bound to be solutions for all the problems in our pursuit of learning. Understanding this idea is of great importance for the future of all the young researchers in China. And I hope those youngsters will spare no effort in going an extra miles and beyond.