The **ERC** Starting Grant

Supporting the next generation of research leaders in Europe

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EUROPEAN COMMISSION

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Supporting the next generation of research leaders in Europe

2008

Directorate-General for Research
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Personal message from the **ERC** President

With the creation of the European Research Council (ERC), the European Union has acknowledged that investing in the most talented researchers is not an option but an imperative to secure Europe's future prosperity and competitiveness in a globalised world. Often referred to as a benchmark for European research excellence, the ERC stimulates aspiration, boosts achievement, and raises the visibility of research and talent.

The ERC Starting Grant funding scheme aims to fast-track the career development of the very best research talent from across the globe, whether working in or moving to Europe. Entrusting up-and-coming research leaders with early scientific independence allows them to fully develop their creative potential.

Whilst the ERC offers attractive, multiannual funding, the host institutions are expected to guarantee appropriate administrative support and attractive working conditions, as this is critically important for recruiting and retaining top researchers, and for fostering their excellence.

This brochure presents the main features of the ERC Starting Grant scheme, as exemplified by six selected case studies from the first Starting Grant competition.

I hope you will find it inspirational reading.

Professor Fotis C. Kafatos, FMRS
ERC President and Chairman of its Scientific Council

Wanted:
the most talented scientists and scholars with scientific leadership potential

The ERC Starting Independent Researcher Grant, otherwise known as the Starting Grant, was created by the European Research Council (ERC) as a response to insufficient funding opportunities for young researchers who are at an important developmental stage in their careers. Grants of this kind fill a critical gap in science where waste and loss of research talent is often a reality. The Starting Grant scheme recognises that research talent needs to be provided with the means for early career independence.

For many talented young researchers, breaking away from working with a supervisor to becoming an independent research leader is difficult, fraught with a lack of suitable structural mechanisms to support such a transition. The overwhelming response to the first ERC Starting Grant competition in 2007 was proof of the need for this kind of support in Europe. The scheme builds on the experience of the former European Young Investigator Award scheme (EURYI) and the Marie Curie Excellence Grants, but with extended scope and more financial means than its prestigious precursors.

Is this you?

The Starting Grant is targeted at emerging researchers (known as principal investigators or PIs) with proven capabilities, wanting to start or consolidate a research team ([1]), and conduct independent research in Europe. To be competitive, PIs must be able to demonstrate a solid record of early research achievements, and also have proof of their potential for scientific independence and leadership in relation to their chosen field.

Successful PIs are provided with support (up to EUR 2 million for a period of up to five years) to fund research in any field of science, engineering and scholarship. They may be of any nationality, and any age, provided that they have held a PhD or equivalent degree (e.g. MDs with specialisation) for at least three years and less than eight years prior to the call for proposals. Certain career breaks – such as maternity/paternity leave, national service, long-term illness or leave taken for unavoidable statutory reasons – may qualify for an extension of this period by up to two years.

The research must be conducted in a public or private research organisation (known as a host institution) located in one of the 27 EU Member States ([2]) and 11 Associated Countries ([3]).

How do I apply?

An ERC grant application should be submitted by a single PI with the support, and on behalf of, the host institution. It can be submitted only in response to an open call for proposals via the web-based Electronic Proposal Submission Service (EPSS). Calls for Starting Grant proposals are launched once a year in the summer season (normally late July each year) with deadlines in autumn.

Potential applicants should consult the *ERC Guide for Applicants – Grant Schemes.*

Who assesses the proposals?

The ERC has a rigorous international peer review system in place to assess its grant applications. It is based on 25 evaluation panels comprised of experts from all scientific fields. The panels assess

> … providing individual researchers from across the globe with the resources, trust and freedom to perform pioneering, high-risk projects with breakthrough potential.

and mark applications based on scientific excellence as a sole criterion, which is applied to both the proposed research project and the PI. Typically, a panel consists of a chairperson and 10 to 14 panel members. Panels may be assisted by additional peer reviewers who provide individual assessments on a proposal-by-proposal basis. Each Starting Grant application is evaluated by at least three peer reviewers, and may include an interview of the PI by the relevant evaluation panel.

To learn more about the ERC's peer review system, consult the *ERC Guide for Peer Reviewers – Starting Grant Scheme.*

Where can I get hands-on information and advice?

National Contact Points (ERC NCPs) have been set up across Europe to provide information and personalised support to ERC applicants in their native language.

For more information, including a copy of the guides mentioned above and details on the ERC NCP in your country, log onto the ERC website at **http://erc.europa.eu**.

The ERC calling card: forging new paths for pioneering science

The European Research Council (ERC) implements the Specific Programme 'Ideas' of the EU's Seventh Research Framework Programme (FP7), 2007-2013. As well as a flagship component of FP7, the ERC is also the first European funding body for frontier research. Its mandate is to support top research leaders and nurture talented emerging researchers to achieve their potential. More specifically, the ERC pledges to support investigator-initiated research that is at the leading edge of science. This means providing individual researchers from across the globe with the resources, trust and freedom to perform pioneering, high-risk projects with breakthrough potential.

Since its inauguration in 2007, the ERC has launched two mainstay support schemes: the ERC Starting Independent Researcher Grant (Starting Grant), and the ERC Advanced Investigator Grant (Advanced Grant). Both operate without the parameters of prescribed themes, and, provided work is conducted within the EU and its Associated Countries, there are no restrictions on the nationality and age of the principal investigator to be funded. The objective behind this novel approach is to encourage creativity and diversity in science, and to attract and retain the very best research talent and established research leaders to and in Europe.

While the Starting Grant is targeted at researchers in the early stages of their independent careers, the Advanced Grant allows established researchers to apply for funding for pioneering, far-reaching research endeavours. Such research should combine high-risk with high-impact potential, break established disciplinary boundaries or explore new productive lines of scientific enquiry, methodologies and techniques. The maximum funding for an Advanced Grant is EUR 3.5 million for a period of up to five years.

(1) In certain fields, such as the social sciences and humanities, but also mathematics, research is often performed individually, aside from guiding research students. The term 'team' is therefore used in the broadest sense, and includes cases where an individual works independently, and conducts an independent research programme.

(2) Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvian, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

(3) Albania, Croatia, Iceland, Israel, Liechtenstein, the Former Yugoslav Republic of Macedonia, Norway, Republic of Montenegro, Serbia, Switzerland, Turkey.

A landmark decision

The ERC became a reality in February 2007 when it was legally established by the European Commission. The ERC has been allocated EUR 7.5 billion under FP7 to develop and implement a substantial suite of funding activities during its seven-year tenure. Its funding strategy and methodologies (including the peer review system) are defined by an independent body of distinguished scientists known as the Scientific Council.

Facts and figures: results from the first Starting Grant competition

The resounding popularity of the ERC's first funding competition for Starting Grants in 2007 was confirmation that the scheme responds to a vital need of Europe's scientific community. A total of 9 167 proposals were received, of which almost 300 were selected for funding. The total budget for the call was EUR 335 million, which represents an average funding of EUR 1.1 million per grant.

Of the successful grantees, 45% have a physical sciences and engineering focus, followed by 36% with life sciences and medicine objectives, and 19% exploring social sciences and humanities themes.

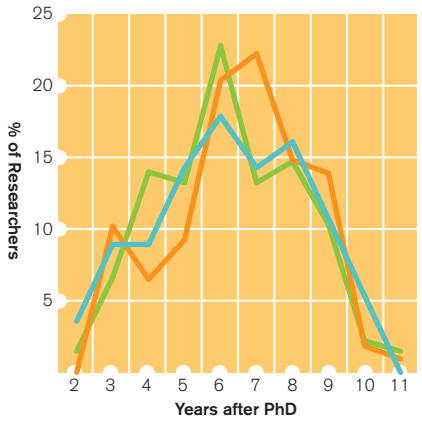
In terms of gender distribution, 48% of grantees in the social sciences and humanities domain are women – a significantly higher percentage than in the physical sciences and engineering (21%) and life sciences (20%) domains.

The average age of the grantees is 35 years (ranging from 28 to 44, with one grantee aged 24), with six years being the mean for the number of years of experience after completion of their PhD.

- Life Sciences
- Physical Sciences and Engineering
- Social Sciences and Humanities

Grantees' profile: years after PhD and domain

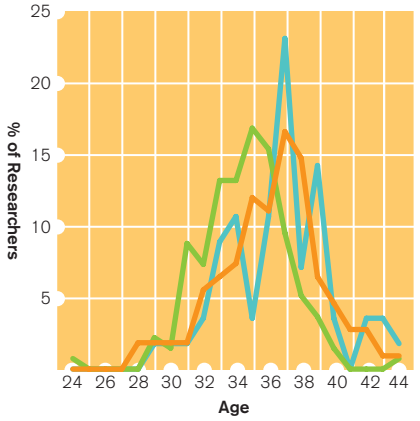
The greatest number of principal investigators completed their PhD studies between five to eight years before applying for a Starting Grant, irrespective of the domain.



Source: Top 300 proposals

Grantees' profile: age and domain

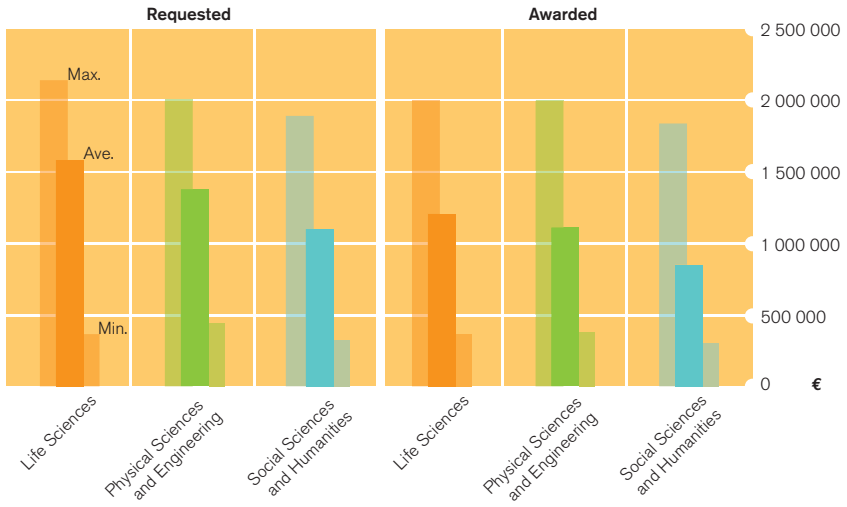
The average age of the principal investigators varies across the domains: Physical Sciences and Engineering (34.5 years); Life Sciences (36 years); Social Sciences and Humanities (36.5 years).



Source: Top 300 proposals

Requested and awarded project budgets: maximum, average and minimum amounts

Project budgets range from € 300 000 up to a max of € 2 million; this is largely independent of the domain.



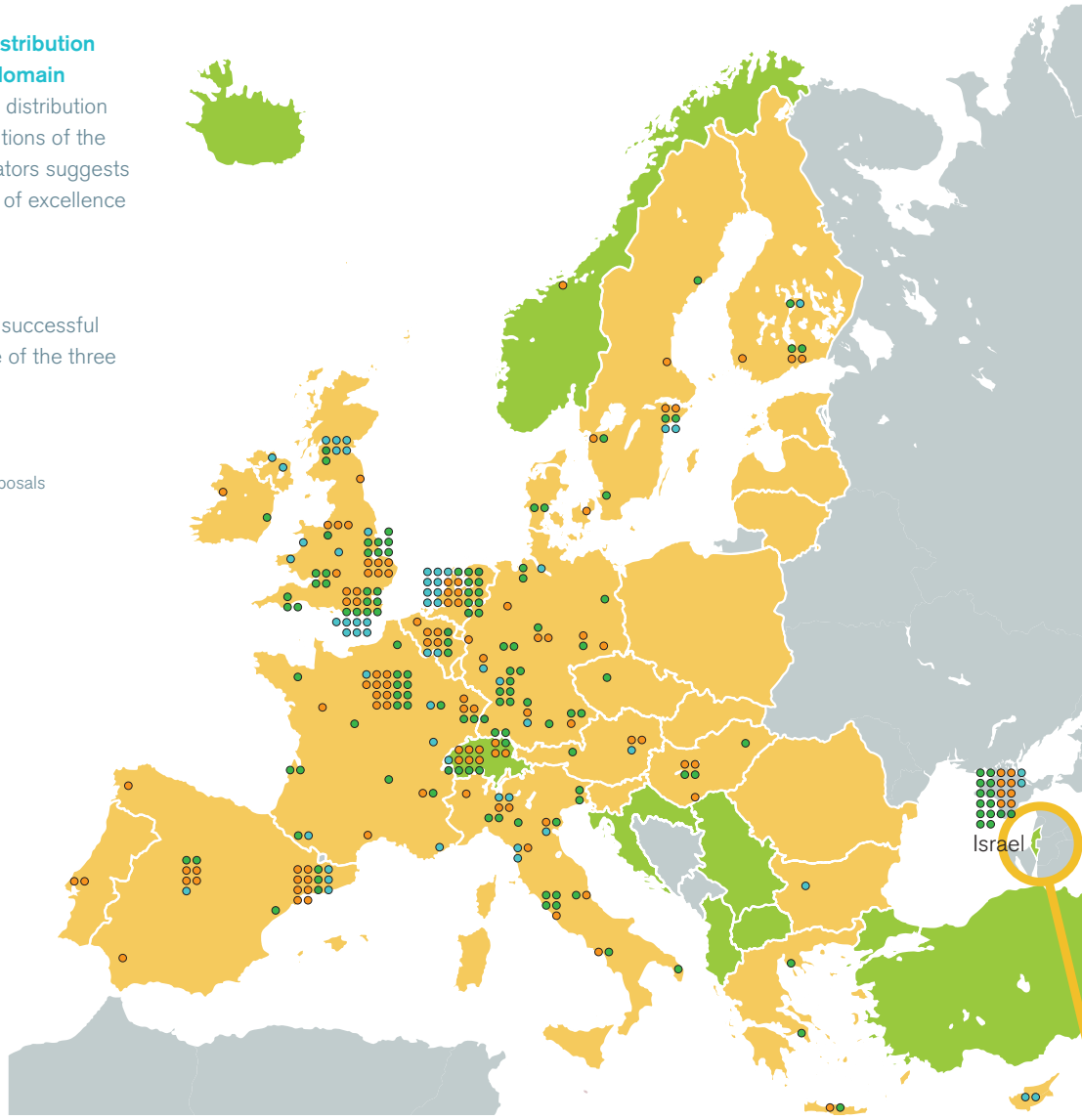
Source: Top 300 proposals

Geographical distribution of grantees by domain

The geographical distribution of the host institutions of the principal investigators suggests potential clusters of excellence in Europe.

A dot indicates a successful application in one of the three domains.

Source: Top 300 proposals



Preparing for tomorrow's computers

Quantum computing promises to add subtle grey shades to the black-and-white logic of today's digital computers, replacing the binary strings of '0's and '1's now used to encode data with the unit of quantum information known as a 'qubit'. Starting Grant recipient Julia Kempe, a highly qualified international researcher now working in Israel, will bring a similarly sophisticated mix of physics and mathematics to the study of phenomena that will provide unprecedented problem-solving powers to the IT tools of the future.

Born in East Berlin, Julia Kempe has always been consumed by a thirst for knowledge. 'Even as a very young child, I was constantly asking my parents to give me riddles and puzzles to solve,' she recalls. This natural curiosity remains as strong today, driving her to pursue a career path of intense study and achievement that has marked her out as one of Europe's outstanding young researchers – and a worthy recipient of the ERC Starting Grant.

Road to IT revolution

Her chosen field, quantum computing, has the potential to revolutionise information technology. Today's digital computers store and manipulate 'bits' of data, which can be considered as strings of on/off signals or '0's and '1's. In contrast, a quantum computer would obey the laws of quantum physics, which take over from classical physics at the atomic scale of matter. Here, the fundamental unit of information (the qubit) can exist not only as a 0 or 1, but also as a blend or superposition of the two, when it behaves as if it were in both states simultaneously.

This curious phenomenon holds the key to a massive boost in the power of computers to solve problems that are beyond present capabilities. It has been the subject of international research interest since Peter Shor's breakthrough announcement in 1994 of an algorithm making it possible to derive the prime factors of very large numbers within an acceptable timeframe – something that cannot be achieved with classical computers.

Shor's discovery is not just of academic interest; it could, for example, show the way to defeat the cryptographic systems currently employed to safeguard online financial transactions and secure sensitive databases.

Early promise fulfilled

Julia's progress into this esoteric world began in her early years, when she was soon earmarked for a place at a school for gifted pupils. In this stimulating environment, she learned problem-solving skills that helped her to win several national prizes in mathematics and science.

Shortly after the fall of the Berlin wall in 1989, the Kempe family left East Germany for Austria, where Julia gained degrees in both maths and physics at the University of Vienna. During this time, an exchange visit to Sydney's University of Technology fired her interest in discovering new locations and acquiring new experiences.

Her next move was to France, where she mastered in algebra at the Pierre and Marie Curie University, Paris, and in theoretical physics at the city's École Normale Supérieure. Armed with an impressive array of qualifications at the age of only 23, she went on to accept the gruelling demands of simultaneous PhD programmes in quantum computing – one in Paris, the other at Berkeley University, California!

This remarkable record led to the early offer of a position as permanent researcher at the *Centre Nationale de Recherche Scientifique* (CNRS),

> Having operated more or less independently throughout my career to date, the EU funding will enable me to build a group of students and pass on some of my passion for crossing traditional boundaries.

France, where the liberal rules gave her the freedom to spend more time pursuing post-graduate studies at Berkeley and elsewhere.

In 2006, Julia won a CNRS bronze medal and the Prix Joliot-Curie as France's outstanding young female researcher of the year. She was also awarded an Alon Fellowship by the Higher Council for Academic Studies in Israel, which provided basic support for a three-year tenure at Tel Aviv University.

'I applied for a Starting Grant after learning about them from the university's funding department. Naturally, I was very happy to hear that my proposal had been accepted,' she says. 'Having operated more or less independently throughout my career to date, the EU funding will enable me to build a group of students and pass on some of my passion for crossing traditional boundaries.

'It is fortunate that the provisions of the ERC scheme are such that I could qualify while working in an Associate Country. I am obviously a firm believer in researcher mobility, and am actively collaborating with quantum computing groups around the world.'

New research direction

Julia's plans for the QUCO project straddle the divide between algorithm design, cryptography, complexity and physics. The overarching idea is not only to explore the power of quantum machines, but also to identify their limits. 'We do not yet know what form a quantum computer would actually take,' she points out. 'It could be a decade or more away, but meanwhile there are many fascinating avenues for theoretical investigation.

'So far, most research has addressed areas where quantum computers are much faster, or otherwise better, than classical computers. We propose to turn this around and look for problems that remain hard even for a quantum computer – and which might form the basis of new, secure cryptosystems. Information is a crucial commodity to the economy and society at large. It must be protected not only against current computational challenges, but also against future quantum-equipped attackers.'

A second aim is to ascertain the power of quantum resources, such as entanglement (the sharing of a quantum state between two parties) and its effects in quantum communication. Quantum memory is another resource that could become available long before a functional quantum computer is built. 'In this context, we again propose to focus on a cryptographic theme, namely how current classical cryptographic schemes could be compromised if an adversary has quantum memory at his disposal. We would also like to further explore the computational power of quantum machines and quantum physical systems in complexity theory terms, comparing them with their classical counterparts.'

Thirdly, an interesting trend in quantum computation is the 'reverse' flow of techniques and results, using the quantum information toolbox to answer classical questions. 'Many theoretical findings from the quantum world could no doubt be exploited in the classical arena,' Julia maintains. 'We propose to explore the connections in algorithm design and learning theory, and to initiate a systematic way to obtain classical results the 'quantum' way.

'The Starting Grant will allow me to hire postdoc, PhD and master's students to share in this exciting project, as well as inviting visitors and providing for material and travel costs on a scale appropriate to a leading research team.'

Principal Investigator
Julia Kempe

Nationality, age
German, 34

Project title
The Power of Quantum Computers

Acronym
QUCO

Host Institution
Tel Aviv University
School of Computer Science
Schreiber 121
69978, Tel Aviv, Israel

Grant
EUR 744 000

Project duration
60 months

Further information
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www.cs.tau.ac.il/~kempe/

Polar ice charts climate change millennia

Traces of microalgae that have been present only in polar sea ice over many thousands of years provide a remarkably accurate record of long-term climate change. UK-based French researcher Guillaume Massé has developed a method to measure, whenever the ice has melted in a particular area, the chemical remnants of these living organisms in layers of sediment deposited on the sea-bed. With the support of an ERC Starting Grant, he will mount ambitious sampling trips to both the Arctic and Antarctic, yielding data that will enhance our understanding of the current global warming threat.

Guillaume Massé's attraction to the sea began with an early love of scuba diving in his homeland France. He went on to gain a technical degree from the *Institut des Sciences et des Techniques de la Mer,* Cherbourg, and worked for four years as a research assistant at the University of Nantes.

In 1999, he moved to the UK, first as a research assistant and then to pursue a doctorate in chemistry under the supervision of Professors Steve Rowland and Simon Belt at the University of Plymouth. Here, his study of a special class of compounds synthesised by certain microalgae proved once again to have a connection with his interest in the maritime environment.

The work involved collection, identification and culturing of several diatom species as the basis for the study of unusual molecules previously reported in marine sediments. It included the structural characterisation of numerous lipids, called C_{25} and C_{30} highly branched isoprenoid (HBI) alkenes, as well as an investigation of the influence of environmental parameters on the synthesis process.

On completing his postdoctoral term at Plymouth in August 2003, he was appointed as a 'New-Blood' lecturer in the university's Petroleum and Geochemistry Group. This enabled him to devote the majority of his time to the development of new research projects in close collaboration with more senior colleagues.

Impact for all mankind

'I was interested in getting more information about the source organisms and discovered that some of them lived in the Arctic and Antarctic sea ice,' Guillaume explains. 'My colleagues and I postulated that certain HBIs may be synthesised specifically in the ice, and might be used as markers of its historic presence.

'This would be of real value in establishing the climatic evolution of the geological past, and in helping us to determine the extent of current global warming. We have detailed satellite data on the ice caps since the seventies, but records for earlier periods are less accurate or non-existent.

'Changes in sea ice extent, timing, thickness, and seasonal fluctuations are already having an impact on the people, plants, and animals that live in the Arctic. They are also of great relevance to mankind as a whole. Periods of sea ice cover frequently coincide with dramatic changes to human populations due to famines and illnesses, while its decline brings the risk of flooding and shifts in the pattern of oceanic currents.'

Fieldwork proves theory

In 2004, Guillaume obtained a small grant to test his theory. With the help of Canada's Museum of Nature and the ArcticNet Network of Centres of Excellence, he was able to go to the Arctic for the first time in the spring of 2005. During this trip,

> The assured five-year funding of the Starting Grant is providing the 'cement' to structure a major effort that will show European leadership in addressing the overriding environmental concern of our age.

he collected ice cores and sediment from underneath the ice. Subsequent analysis back in Plymouth confirmed that HBIs were present in both.

With further funding from the UK Natural and Environmental Research Council, he participated in the ArcticNet 2005 cruise, gathering sediment samples from across the Canadian archipelago. The results obtained showed that a unique mono-unsaturated HBI lipid produced within sea ice can also be detected in polar sediments and therefore used as a reliable biomarker, or 'proxy', for present and past sea ice.

As well as being unique to sea-ice diatoms, the HBIs are relatively resistant to degradation, while their relative abundance makes them straightforward to measure with a high degree of geological resolution. Samples collected using a large metal scoop known as a box-core to extract the upper layers of mud from the ocean floor are divided into slices, each representing between 1 and 20 years of accumulation. The concentration of lipid corresponds to the volume of algae existing at the time of deposition, and therefore indicates how much ice may have been present.

Main scientific interest focuses on the earth's current inter-glacial period — the Holocene epoch — which stretches back some 10 000 years. However, Guillaume has observed HBIs in samples as much as 50 000 years old, and suggests that the method could be used to go back even further, although with reducing resolution.

Aiming high

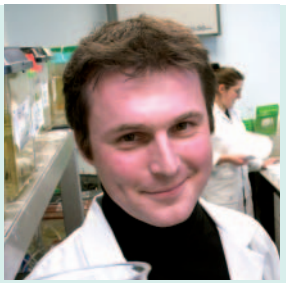
'I learned from the Internet that the Starting Grant scheme was seeking to fund ambitious initiatives, so decided to target my proposal accordingly,' Guillaume says. 'I therefore travelled to several polar research institutions across Europe to give seminars and seek support to obtain samples from both the Arctic and the Antarctic. All of them were really interested and agreed to contribute to ICEPROXY.'

One component of this project will be to perform regional calibrations of the proxies. Concentrations of selected biomarkers in recent Arctic and Antarctic sediments will first be correlated with the sea ice abundances determined using satellite technology over the past 30 years. This calibration stage will enable reconstructions of past sea ice extents to be performed with unprecedented high resolution. The gathered data will then be used for climate modelling studies.

In addition, ICEPROXY will investigate the use of these biomarkers for studying the interactions between sea ice presence and the living organisms of the regions. Examining the transfer of HBIs through food chains will provide new tools for determining the consequences of future climate change on polar ecosystems.

'Recent research predicts that by 2013 summer sea ice will have disappeared completely from the Arctic, which will have a huge impact,' Guillaume observes. 'With the level of detail we will be able to obtain about the past extent of coverage, we will gain a much better understanding of the consequences of such a dramatic decline, and of the overall role of sea ice in the earth's climate.'

'The assured five-year funding of the Starting Grant is providing the 'cement' to structure a major effort that will show European leadership in addressing the overriding environmental concern of our age,' he concludes.



Principal Investigator
Guillaume Massé

Nationality, age
French, 33

Project title
Biomarkers from Polar Ice: Climatic and Ecological Applications

Acronym
ICEPROXY

Host Institution
University of Plymouth
School of Earth, Ocean and Environmental Sciences
Drake Circus, Plymouth, PL4 8AA, United Kingdom

Grant
EUR 1 880 000

Project duration
60 months

Further information
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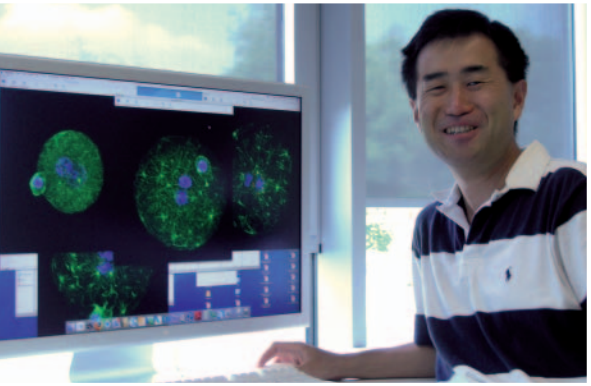
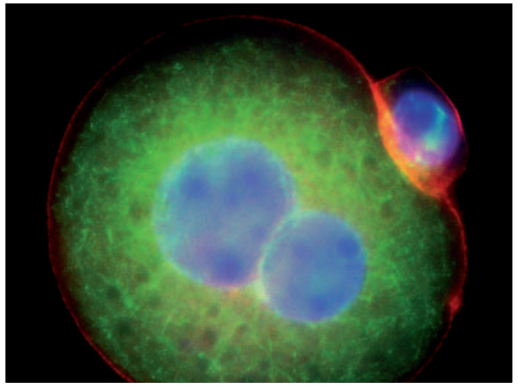
www.research.plymouth.ac.uk/pegg/staff/Masse_G/gmasse.htm

What shapes the beginning of life?

The reason why the fertilised eggs of mammals develop differently from those of other animals is an intriguing and, as yet, unsolved mystery. Japanese medical scientist Takashi Hiiragi joined a prominent expert in Germany in his search for the answer. Eventually deciding to set up as an independent researcher, he considered various world locations before deciding that Europe offered the most conducive environment for further research. An ERC Starting Grant has helped him establish his own laboratory and team to continue the quest.





Fascination with the way that the human body repairs itself and recovers from disease set Takashi Hiiragi on the path to becoming a medical doctor in his native Japan. Born in Osaka in 1967, Takashi qualified as an MD at the Kyoto University Faculty of Medicine in 1993, and undertook a two-year internship as a general practitioner at the Kobe City Central Hospital. Before its conclusion, however, he recognised that his real interest lay in research, and decided to pursue a doctorate in the Department of Cell Biology at Kyoto University.

'I learned a lot about modern cell biology, but was keen to move on after the PhD. I particularly admired the work of Dr Davor Solter at the Max-Planck Institute of Immunobiology in Freiburg, Germany, so applied to join him.'

No holy grail

Dr Solter led one of several groups around the world investigating a mystery surrounding the early growth of mammalian embryos. 'At one time, scientists were seeking a universal principle underlying the development of all living creatures,' Takashi explains. 'But the facts simply do not fit.'

When cells from two very early-stage embryos of an animal species such as a fish or frog are mixed in the laboratory, subsequent growth produces a creature with abnormalities, such as two heads or extra limbs. This implies that the role of individual cells is somehow predetermined at the outset. When the same experiment is repeated with mouse embryos, however, they continue to develop as normal animals.

As a mammalian egg travels from the fallopian tube following fertilisation, it develops a surrounding structure known as the trophectoderm (TE). This implants into the wall of the uterus, where it grows and forms the placenta including umbilical cord as the link to the foetus. Although intimately connected to the embryo, the placenta is not actually a part of it.

In the first three days, cell division within the egg leads to the formation of a unique structure, the blastocyst, composed of an inner cell mass (ICM), surrounded by a single layer of epithelial cells (TE). The ICM goes on to form the embryo, while the placenta is created from the TE.

The puzzle for scientists is to determine how, and at what point, individual cells are assigned their embryonic or non-embryonic roles.

This challenge was irresistible to Takashi. In 2000 – by then married to Yuka, an accomplished pianist – he moved to Freiburg as a postdoc fellow. 'We were a little apprehensive about the change of culture,' he admits, 'but it proved to be problem-free. We were made most welcome, and Yuka was able to obtain a teaching post at Freiburg Music College.'

Pioneering developments

During his two postdoc years, Takashi developed a mouse cloning procedure that he now uses routinely and teaches to PhD students. He then became a junior group leader in the department of Developmental Biology for a further five years.

> When my institute pointed out that the Starting Grant scheme would support me as a foreign national making a positive contribution to Europe, it seemed like an ideal opportunity.

'Eventually, I felt as though I had effectively inherited the philosophy and work of Dr Solter's science, so decided to set up an independent laboratory to pursue it further.'

Meanwhile, he had established a novel time-lapse imaging system that allows real-time recording of the actual growth of pre-implantation mouse embryos. This led to the first unequivocal demonstration that the animal-vegetal or embryo-placenta axis of the mouse embryo is not predetermined, as some had postulated. Following a 2004 landmark publication in *Nature* co-authored by Solter and Hiiragi, the technique has since been taken up by other workers around the world.

The Solter/Hiiragi hypothesis is that the polarisation of embryos could be effected by mechanical constraints imposed by the zona pellucida: a surrounding membrane with an ellipsoidal shape that restricts the coalescing blastocyst cavities at one end of its long axis.

The mechanism is indeed unique to mammals, and may be a relatively recent evolutionary development. Yet few of the molecules involved in initiating and maintaining the cellular divergence have so far been identified. Takashi's aim is to fill this knowledge gap by combining new biological marking techniques with computer modelling, eventually enabling genetic screening to be carried out for the first time on the early mouse embryos.

Europe holds attractions

'This evidently requires considerable additional resources, so I looked around the world in search of a location where I could best continue on an individual basis,' he recounts. 'Realising that the EU is a particularly strong backer of fundamental research, I decided to stay – setting up in the Max-Planck Institute for Molecular Biomedicine, Münster. When my institute pointed out that the Starting Grant scheme would support me as a foreign national making a positive contribution to Europe, it seemed like an ideal opportunity.

'I was naturally very pleased to learn of the successful outcome of my application, particularly as the prime criterion is the quality of the research. The security of the long-term funding will enable me to adopt a challenging strategy, acquire dedicated microscope systems to handle our specialised samples, and work on a more sophisticated version of my live-imaging system to refine our observations and extract still more information.'

Takashi maintains that his own motivation is a pure thirst for scientific knowledge. His findings will shed more light on the very beginnings of our existence as living beings – but they could also point the way to new treatments for the human diseases that first inspired him to enter the world of medicine.

Principal Investigator
Takashi Hiiragi

Nationality, age
Japanese, 40

Project title
Mammalian development

Acronym
MammalianDevelopment

Host Institution
Max-Planck Institute for Molecular Biomedicine
Mammalian Development Laboratory
Röntgenstraße 20
48149, Münster, Germany

Grant
EUR 1 150 000

Project duration
60 months

Further information
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Grandmothers are key to human longevity

While most animals die soon after losing the ability to reproduce, the human lifespan continues for many more years. The reason behind this apparent evolutionary oddity may be that the survival of women allows them to devote more effort to helping adult offspring produce a further generation – which could be the most efficient strategy for success. With the support of an ERC Starting Grant, Finnish zoologist Virpi Lummaa aims to prove that caring grandmothers are drivers of genetic continuity and proliferation.

Photo by Esko Pettay

'I actually always wanted to study chimpanzees in the wild, like the famous Jane Goodall who lived in the jungle and was my childhood hero,' says Virpi Lummaa, currently a Research Fellow at the University of Sheffield. 'But, recognising the difficulty in obtaining adequate and continuous data throughout the lifetimes of wild animals, I turned my attention to the human race.

'The fact that our species keeps detailed written records is a huge advantage. One of the best sources is church archives, because you can go far back in time to obtain very long pedigrees that show how things change from one generation to another.'

Virpi's research concentrates on two main topics: the use of modern evolutionary theory to investigate how human demography and reproductive strategies are determined in given environmental settings; and the effects of early conditions on subsequent health, growth, survival and reproductive success in historical human populations, and in contemporary developing countries.

Since starting her PhD in 1997, she has been assembling a large database covering the pre-industrial populations of communities in a relatively isolated archipelago of her native Finland, spanning the period from 1700 to the early 20th century. 'This was an ideal location, because everyone belonged to the same Lutheran church – and, with the late arrival of industrialisation in the area, mobility was limited,' she notes. 'Moreover, the clergy were obliged to provide the state with records as the basis for tax collection, so they had to be particularly accurate and complete.

'Given that population ageing is an issue of growing concern in western societies, and that current models have failed to predict demographic transitions in many developing countries, I have also started collaborations on similar datasets collected from historical Canada and contemporary rural Gambia.'

Evolutionary enigma

Unlike most mammals, which experience senescence (age-related deterioration) and die soon after losing the ability to reproduce, human females commonly survive for many years beyond menopause. While the fertility of female chimpanzees declines at around the same age as in humans, their subsequent survival rates are extremely low. Yet women may continue to live for 25 years or more. This is not confined to modern society either. Both in historical times and in traditional hunter-gatherer populations with low life-expectancy at birth, around 30% of adult individuals live for more than 45 years.

The common evolutionary imperative is to maximise the numbers of surviving grandchildren, which is normally achieved by breeding throughout life. In this respect, human females pose an enigma. One possibility is that, rather than producing more children themselves, they increase the numbers of grandchildren by directing their resources to helping and caring for already produced offspring, thus improving their prospects of child raising.

> Acceptance of the proposal has helped me to assemble a multidisciplinary team comprising three postdocs, several PhD students and two technicians – and I can balance my life as a single mother by working from home when necessary.

'Although this is not yet proven, my research shows that women in pre-industrial populations gained 2 extra grandchildren for every 10 years of survival beyond the age of 50. Hence, women with genes for living beyond the decline in fertility may produce more family members, better assuring the continuity of their bloodline,' Virpi says.

Perfect fit

Her own interest in this process took on a more personal context when she gave birth to her own son, Eelis, in 2007. 'My baby had just been born when my head of department suggested I apply for the grant. I thought the timing was very bad, as I had hardly slept for a month! However, when I read the description, I soon realised it would be perfect for me.

'The position of my research topic at the interface between evolutionary biology, medical epidemiology, historical demography and anthropology had made it difficult to secure funding from conventional sources. Acceptance of the proposal has helped me to assemble a multidisciplinary team comprising three postdocs, several PhD students and two technicians – and I can balance my life as a single mother by working from home when necessary.'

Compromise for survival

Indeed, life-balance is a central theme of the project itself.

'Reproduction is costly in bodily terms,' Virpi points out. 'Producing many babies at a young age reduces the resources available for the maintenance of a healthy immune system. This may affect an individual's own survival prospects in later years, due to greater susceptibility to infectious diseases. Most animals maximise survivability by managing the relative investment between early and later reproduction. Human women must not only optimise this trade-off, but also that between their stages of mothering and grandmothering. Although some, particularly the wealthy, can succeed in both rearing large families and enjoying long life.'

The new research will determine whether human evolution has given rise to a life-pattern that automatically terminates female fertility when the benefits of helping existing offspring to reproduce outweigh the costs of continued breeding. Explaining how this could occur and how it is affected by ecological, social and demographic circumstances is essential to understanding the genetic basis of reproductive effort, senescence and lifespan.

By exploring differences between the ways in which men and women maximise their succession, the study could also explain why men also enjoy similarly prolonged lives, despite evidence that they make a lesser direct contribution to caring for offspring.

Principal Investigator
Virpi Lummaa

Nationality, age
Finnish, 34

Project title
Mothers, Grandmothers and the Evolution of Prolonged Lifespan in Humans

Acronym
HUMAN LIFESPAN

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Grant
EUR 1 143 824

Project duration
60 months

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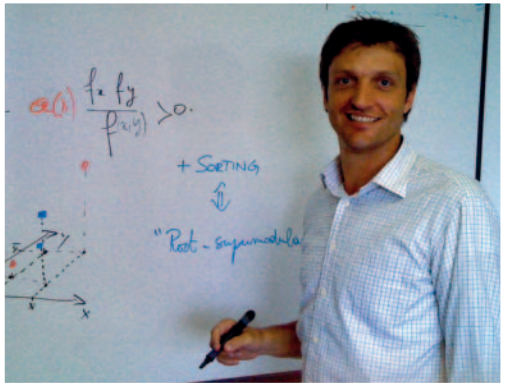
Natural matching determines prosperity of nations

Sorting – the formation of situation-specific bilateral relationships – is prevalent in many economic contexts. Highly skilled workers gravitate to the most productive managers, experienced venture capitalists finance more successful start-ups, buyers link with the appropriate sellers, and so forth. Belgian economist Jan Eeckhout is seeking to define the role of sorting in economic development and market-shaping forces. An ERC Starting Grant will enable him to return to Europe to build on a successful line of research he started in the United States in 2000. It could provide a new explanation for global inequalities in employment opportunities and wealth creation.



A desire to discover the reasons behind wage inequality around the world, and whether a move to greater equality would compromise business efficiency, drove Jan Eeckhout to follow his particular path in economics research. 'You begin with a 'gut feeling', but to get to the truth you need to move to more rational, non-intuitive ways of thinking,' he observes. 'These are fundamental questions about the quality of life for all people.'

After graduating from Belgium's Catholic University of Leuven in 1992, Jan headed for the United Kingdom to complete a Masters degree at Manchester University and a doctorate at the London School of Economics. Through the 1990s and the early part of the next decade, study visits and an EU Marie Curie fellowship took him to Spain, Italy, Israel and the US.

During his travels, he met and married his Spanish wife, who is now the mother of their two young children. In 2000, the couple moved to the US, where Jan spent eight years at the University of Pennsylvania, eventually becoming Associate Professor in the Department of Economics. Meanwhile, he had been pursuing his theories about the process of sorting as an influence on markets and economic development.

'In the process of development, there is occupational sorting in the allocation of workers to managers,' Jan explains. 'Due to globalisation and improved communications, managers now have access to a broader labour market. Electronic devices which are designed and developed in the US, may be manufactured in Taiwan and sold worldwide.

'Analysis shows that the share of gain from this activity is largely influenced by sorting, which has substantial implications for inequality and poverty. The main beneficiaries prove to be the countries with both the lowest and the highest skilled workers, while the medium-skilled regions are least advantaged.'

Milestone publication

His 2004 *American Economic Review* paper on the interaction between prices, mobility and the size of urban populations drew great international attention. 'It appears this research has changed applied economists' way of thinking,' Jan asserts. 'It formalises how citizens sort into different cities by 'voting with their feet' in response to shifts in economic activity, and to the resulting changes in prices and wages.'

The findings overturn earlier conclusions about population distribution, and have provided a robust framework for analysing such phenomena as house price dynamics and consumption shares. They show that the simple theory of sorting is highly relevant to a number of economic issues.

Previously, Jan's research group was one of several to advance the concept of 'two-sided matching' between pairs of agents or agent groups, such as employees and managers, or children and schools. It can be observed that the actions of one agent influence those of the counterpart in a positive or negative way. Thus, for example, if a player in a card game raises the stakes,

> When I began, there was no EU equivalent to the US National Science Foundation and National Institutes of Health; now, the ERC initiative presents a great opportunity to continue my research in Europe.

his opponents may be impelled to follow suit (an effect known as supermodularity).

'In markets where the sorting process is impeded by internal frictions, the result is a division into partitions or classes,' Jan adds. 'Imperfect sorting occurs between members of the same class, yet there is still perfect segregation between classes. This mode of class formation was a surprising discovery, and has since been used in several more studies.'

New impetus in Europe

Having learned about the Starting Grant scheme through exchanges with academic colleagues, he decided to apply, remarking, 'When I began, there was no EU equivalent to the US National Science Foundation and National Institutes of Health; now, the ERC initiative presents a great opportunity to continue my research in Europe.'

On learning of his success, he opted to return to the Universitat Pompeu Fabra in Spain, where he had already spent a short period as Assistant Professor of Economics in 1997. By expanding the research programme he started in the US, Jan aims to provide testable hypotheses for the role of sorting in development and market design, and improve the testability of two-sided matching in markets.

Earlier work concluded that sorting between workers and firms was not significant, but more recent studies have shown that the method used would not detect the effect (of sorting), even in situations where it was actually extremely important.

'We have uncovered what exactly was picked up in those earlier measurements, and are setting out to provide a new way to determine the influence of sorting,' says Jan. 'Knowing the strength of its impact can inform labour market policies – should we structure unemployment insurance in ways that encourage people to search for the 'right' jobs, or is it better to subsidise education as a tool for redistribution?'

The grant will allow him to explore some higher-risk avenues in answering such questions. He will set up a team of doctoral students and postdocs, and establish an efficient, laboratory-like infrastructure. The team will also profit from access to an international network of well-established researchers, with whom Jan now regularly collaborates.

'This will certainly lead to synergies and generate a richer skill set to tackle the major questions,' he maintains. 'It will also allow us to spread the methods of sorting to a larger audience. In doing so, it will enhance the reputation of Europe as a centre of research excellence.'

Principal Investigator
Jan Eeckhout

Nationality, age
Belgian, 38

Project title
The Role of Sorting for Estimation, Market Design and Development

Acronym
SORTING

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Grant
EUR 550 000

Project duration
60 months

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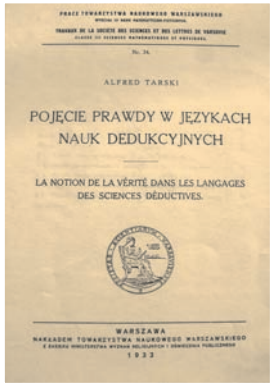
What is truth?

The concept of truth plays a central role in our cognitive lives, and has been the preoccupation of philosophers since the times of Plato and Aristotle. In the 1930s, Polish logician Alfred Tarski was the first to express truth in mathematical terms, but the roots of his work have since remained largely in the shadows. An ERC Starting Grant will enable a team headed by Italian Arianna Betti to explore his revolution in semantics, bringing deserved prominence to the highly original Eastern European school of thought.



Logic and the processes of analytical thinking have been overriding interests in the life of Arianna Betti since her youth in Italy's Tuscany region. Her commitment to her chosen subject of the Austro-Polish tradition of philosophy is such that, while completing MA and PhD qualifications in Philosophy of Science, she took time to learn the Polish language and spend periods of study in both countries.

'I was advised to work with existing translated material,' she recalls, 'but did not feel such an approach would satisfy my own standards. The ideas emerging from this region in the early part of the 20th century were both original and highly distinctive. However, the thread was virtually severed by the Nazi invasion in 1939. Since that time, the remaining body of work has attracted little attention. There is a lot of writing in Polish, which I saw as a goldmine for further investigation.'

Following her doctorate, Arianna opted to continue her research from the Netherlands. After periods as a postdoctoral fellow in Leiden and Amsterdam, she assumed the Assistant Professorship of Logic, Philosophy of Language and Metaphysics at the VU University of Amsterdam in 2006.

Truth as mathematics

TRANH, her ERC-supported project, examines the work of logician and mathematician Alfred Tarski (1901-83), who revolutionised semantics – the study of meaning and truth in language – by proposing a mathematical treatment to answer the question 'what is truth?'. 'Through his master Stanisław Leśniewski, among others, Tarski was influenced by the German Gottlob Frege, the so-called father of modern logic, and by the extraordinary work of the Bohemian philosopher Bernard Bolzano in the 1830s.'

Tarski's 'undefinability theorem' states that the concept of truth in a formal scientific language such as a form of arithmetic, for example, cannot be defined using the expressive means of that arithmetic itself (the 'object language'). He shows that it is nevertheless possible to define truth for the object language by drawing on a 'metalanguage' – a language used to talk about another language – provided that its expressive power is greater than that of the object language.

Traditional historical research sees Tarski's achievement as part of a continuous process of discovery and technical development, but misses the significance of the transformation brought about by his approach to semantics. Other interpretations correctly observe a rupture in the historical path, but wrongly associate this with the emergence of metatheory (a theory about another theory) in logic. The goal of TRANH is to establish that metatheory was already present in Bolzano, Frege and Leśniewski, but that the rupture arises from Tarski's specific approach to semantics in the context of the axiomatic sciences of his times (e.g. logic and geometry).

Reinterpreting Aristotle

For more than two thousand years, philosophers have adhered to common standards of scientific rationality, as first put forward by Aristotle.

> My team will be able to profile itself as the reference point in this area, and open new perspectives for neighbouring fields.

Although these have progressively been shaped by, and adapted to, new scientific needs and tendencies, the core conditions defining the so-called Classical Model of Science have remained constant. According to this, a proper science is a collection of very few self-evidently true claims or concepts (the axioms) from which all other claims or concepts belonging to that science follow by necessity.

Tarski challenged the conventional wisdom by maintaining that axioms are not invariably true propositions, but propositional functions containing free variables – and as such are neither true nor false, although they can become true or false under an interpretation. This represents a profound change with respect to the classical conception of science in general, and of semantics in particular.

'My aim is to examine how Tarski arrived at his theory, and to evaluate its broad philosophical impact,' Arianna continues. 'The project will set a new course in this fragmented field of research. It will also highlight the Eastern European analytic tradition, which paid more attention to history and metaphysics than its Anglo-American counterpart, and which is still largely unexplored today.'

Three sub-projects will together address four main questions:

- In what sense is Bolzano a follower of the Classical Model of Science?
- What is the influence of Frege in the light of the Classical Model upon the Lvov-Warsaw School?
- What is the relationship between Tarski's work in semantics and the Classical Model?
- In what way can the Classical Model be used to account for the development of semantics from Bolzano to Tarski?

This investigation will be carried out on the basis of original Polish and German documentation, with the additional participation of one PhD and one postdoc researcher. The principal methodology will be to conduct comparative conceptual analysis of the relevant key notions to be found in these primary sources – i.e. 'truth', 'variable', 'axiom', 'domain' and 'consequence' – as interpreted by each of the philosophers.

'My team will be able to profile itself as the reference point in this area, and open new perspectives for neighbouring fields,' Arianna claims.

'I am very happy that the ERC has decided to foster such basic studies. All too often, there is pressure to modify our direction in order to accommodate more application-oriented goals. We do not necessarily know where our effort will lead, but fundamental research underpins the acquisition of all new knowledge.'

Principal Investigator
Arianna Betti

Nationality, age
Italian, 38

Project title
Tarski's Revolution: a New History

Acronym
TRANH

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Grant
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