

## **Proposta de doctorat Honoris Causa**

Acord núm. 212/2016 del Consell de Govern pel qual s'aprova la proposta de doctorat Honoris Causa.

- Document informat favorablement per la Comissió de Recerca del Consell de Govern de 07/12/2016

Vicerektorat de Recerca  
Barcelona, 15/12/2016

# ACORD DEL CONSELL DE GOVERN PER A CONCEDIR EL DOCTORAT HONORIS CAUSA PER LA UNIVERSITAT POLITÈCNICA DE CATALUNYA, AL PROFESSOR KIP S. THORNE

## Antecedents:

La recent detecció directa de les ones gravitatòries ha permès la confirmació experimental de la darrera de les prediccions de la Teoria de la Relativitat General que encara estava per comprovar. Això no tan sols ha corroborat les previsions d'Albert Einstein, sinó que també ha suposat l'apertura de una nova era per la Física, doncs permetrà explorar, mitjançant una nova finestra observacional a més de la electromagnètica, les propietats de l'Univers. Aquest descobriment, de cabdal importància, ha estat possible mercès a una nova generació de detectors d'ones gravitatòries, que incorporen en el seu disseny impressionants avenços tecnològics, doncs aquests detectors han de tenir unes sensibilitats extraordinàries.

Tot això no hauria estat possible sense la revolucionària visió del Prof. Kip S. Thorne (Feynman Professor of Theoretical Physics del California Institute of Technology). El Prof. Thorne ha estat un dels pioners en aquesta disciplina científica i sense les seves aportacions no es podrien entendre els avenços científics i tècnics que han portat a aquest descobriment excepcional. Les contribucions del Prof. Thorne al desenvolupament científic i tecnològic són nombroses i diverses, como així ho fa palès el currículum vitae adjunt. En particular, el seus treballs no tan sols s'han centrat en àrees exclusivament científiques, com ara la gravitació, l'òptica i l'astrofísica, sinó, també, en àrees de caire marcadament tecnològic, com ara el disseny d'algorismes de processat de senyal, conformant d'aquesta manera una trajectòria professional d'acusat caire multidisciplinari, el que fa d'ell un acadèmic difícil de classificar. L'impacte de la seva tasca acadèmica és absolutament inqüestionable, doncs a dia d'avui els seus treballs han rebut més de 30,000 cites, acredita un índex h de 79, i ha estat el responsable de tota una generació de científics brillants, que van realitzar la seva tesi doctoral sota la seva supervisió. Ha estat també el primer promotor de l'observatori d'ones gravitatòries LIGO, que ha portat a terme la detecció de les ones gravitatòries emeses en la coalescència de dos forats negres, confirmant d'aquesta forma l'existència de parells de forats negres. El Prof. Thorne, a més, ha rebut nombrosos reconeixements de les institucions acadèmiques més prestigioses del món. En definitiva, la trajectòria del Prof. Thorne és reconeguda i admirada per la comunitat científica internacional.

El rector, i promogut pel Departament de Física, ha rebut una proposta formal per invertir al Prof. Kip S. Thorne, com a Doctor Honoris Causa per la Universitat Politècnica de Catalunya, amb els recolzaments que podeu consultar, junt amb el seu currículum vitae, a l'annex 1.

Per tot això, el Consell de Govern

**Acorda:**

Únic.- Aprovar la concessió de doctorat honoris causa per la Universitat Politècnica de Catalunya, al Prof. Kip S. Thorne.

# Kip S. Thorne

## A. Biographical sketch

Born in Logan Utah in 1940, Kip Thorne received his B.S. degree from Caltech in 1962 and his Ph.D. from Princeton University in 1965. After two years of postdoctoral study, Thorne returned to Caltech as an Associate professor in 1967, was promoted to Professor of Theoretical Physics in 1970, became The William R. Kenan, Jr., Professor in 1981, and The Feynman Professor of Theoretical Physics in 1991.

In June 2009, Thorne stepped down from his Feynman Professorship (becoming the Feynman Professor of Theoretical Physics, Emeritus) in order to ramp up a new career in writing, movies, and continued scientific research. His current writing focus is the textbook *Modern Classical Physics*, coauthored with Roger Blandford (to be published in late 2016). His first Hollywood movie was *Interstellar* (directed by Christopher Nolan; screenplay by Jonathan Nolan and Christopher Nolan; produced by Christopher Nolan, Emma Thomas and Lynda Obst; release date November 7, 2014); Thorne was the film's science advisor and an executive producer, and with Lynda Obst he coauthored the *Treatment* from which the movie grew. His principal current research is an exploration of the nonlinear dynamical behaviors of curved spacetime, using computer simulations and analytical calculations.

Thorne's research has focused on gravitation physics and astrophysics, with emphasis on relativistic stars, black holes and gravitational waves. In the late 1960's and early 70's he laid the foundations for the theory of pulsations of relativistic stars and the gravitational waves they emit. During the 70's and 80's he developed mathematical formalisms by which astrophysicists analyze the generation of gravitational waves and worked closely with Vladimir Braginsky, Ronald Drever and Rainer Weiss on developing new technical ideas and plans for gravitational wave detection.

He was the co-founder (with Weiss and Drever) of the LIGO (Laser Interferometer Gravitational Wave Observatory) Project and he chaired the steering committee that led LIGO in its earliest years (1984--87). In the 1980s, 90s and 2000s he and his research group provided theoretical support for LIGO, including identifying gravitational wave sources that LIGO should target, laying foundations for data analysis techniques by which their waves are being sought, designing the baffles to control scattered light in the LIGO beam tubes, analyzing a variety of noise sources and ways to control them, and --- in collaboration with Vladimir Braginsky's (Moscow Russia) research group --- inventing quantum-nondemolition designs for advanced gravity-wave detectors. The LIGO project made the breakthrough discovery of gravitational waves arriving at Earth from the distant universe on September 14, 2015. These waves were produced by the collision and merger of two spinning black holes; the data analysis that revealed the nature and details of this source relied crucially on numerical relativity simulations by the SXS

(Simulate eXtreme Spacetimes) Project, which was co-founded by Thorne and Saul Teukolsky of Cornell University in 2004.

With Carlton M. Caves, Thorne invented the back-action-evasion approach to quantum nondemolition measurements of the quadrature amplitudes of harmonic oscillators---a technique now applicable in gravitational wave detection, in quantum optics, and in nanotechnology. With Clifford Will and others of his students, he laid foundations for the theoretical interpretation of experimental tests of relativistic theories of gravity---foundations on which Will and others then built.

With Anna Zytkov, Thorne predicted the existence of red supergiant stars with neutron-star cores ("Thorne-Zytkow Objects"). With Igor Novikov and Don Page he developed the general relativistic theory of thin accretion disks around black holes, and using this theory he deduced that with a doubling of its mass by such accretion a black hole will be spun up to 0.998 of the maximum spin allowed by general relativity, but never any farther; this is probably the maximum black-hole spin allowed in Nature.

With James Hartle, Thorne derived from general relativity the laws of motion and precession of black holes and other relativistic bodies, including the influence of the coupling of their multipole moments to the spacetime curvature of nearby objects. In 1972 he formulated the hoop conjecture (that any object of mass  $M$ , around which a hoop of circumference  $8\pi GM/c^2$  can be spun, must be a black hole) – a conjecture for which there is now extensive theoretical and computer-simulation evidence but still no firm proof. With students and colleagues he developed the membrane paradigm for black holes and used it to clarify the "Blandford-Znajek" mechanism by which black holes may power some quasars and active galactic nuclei. With Wojciech Zurek he showed that the entropy of a black hole of known mass, angular momentum, and electric charge is the logarithm of the number of ways that the hole could have been made.

With Sung-Won Kim, Thorne identified a universal physical mechanism (the explosive growth of vacuum polarization of quantum fields), that may always prevent spacetime from developing closed timelike curves (i.e., prevent "backward time travel"). With Mike Morris and Ulvi Yurtsever he showed that traversable Lorentzian wormholes can exist in the structure of spacetime only if they are threaded by quantum fields in quantum states that violate the averaged null energy condition (i.e. have negative renormalized energy spread over a sufficiently large region). This has triggered research to explore the ability of quantum fields to possess such extended negative energy.

With a team of ten younger colleagues, Thorne invented tools for visualizing spacetime curvature. These include frame-drag vortex lines, which are gravitational analogs of magnetic field lines and control the twisting of space, and tidal tendex lines, which are gravitational analogs of electric field lines and control the stretching and squeezing of space. Combining these tools with numerical simulations, Thorne and colleagues are currently exploring the nonlinear dynamics of curved spacetime, triggered when spinning black holes collide.

Thorne has been mentor for 52 PhD physicists, many of whom have gone on to become world leaders in their chosen fields of research. With John A. Wheeler and Charles W. Misner, Thorne coauthored in 1973 the textbook *Gravitation*, from which most of the present generation of scientists have learned general relativity. He is also a co-author of *Gravitation Theory and Gravitational Collapse* (1965) and *Black Holes: The Membrane Paradigm* (1986), and the sole author of *Black Holes and Time Warps: Einstein's Outrageous Legacy* (1994).

Thorne was elected to the American Academy of Arts and Sciences in 1972, the National Academy of Sciences in 1973, the American Philosophical Society in 1999, and (as a foreign member) the Russian Academy of Sciences in 1999. He has been awarded honorary doctorates by Illinois College (1979), Moscow State University - USSR (1981), Utah State University (2000), the University of Glasgow (2001), Claremont Graduate University (2002) and the University of Chicago (2008), and has won the Lilienfeld Prize of the American Physical Society (1996), the Karl Schwarzschild Medal of the German Astronomical Society (1996), The Robinson Prize in Cosmology from the University of Newcastle (2002), The Albert Einstein Medal from the Albert Einstein Society in Berne Switzerland (2009), The UNESCO Niels Bohr Gold Medal from UNESCO (2010), The Common Wealth Award in Science (2005), the American Institute of Physics Science Writing Award in Physics and Astronomy (twice: 1969 and 1994), the Priroda [Russian] Readers' Choice Science Writing Award (1989 and 1990), the Phi Beta Kappa Science Writing Award (1994), and the J.D. Jackson Award for Excellence in Graduate Education from the American Association of Physics Teachers (2012), the inaugural Kip Thorne Gravity Award for best depiction of a scientific principle in a feature film -- from the RAW Science Film Festival (2014), and the Space Pioneer Award for Mass Media from the National Space Society (2015). He has been a Woodrow Wilson Fellow, a Danforth Foundation Fellow, a Fulbright Fellow, and a Guggenheim Fellow; and he has served on the International Committee on General Relativity and Gravitation, the Committee on US-USSR Cooperation in Physics, and the National Academy of Science's Space Science Board, which advised NASA and Congress on space science policy. In 1996--97 he organized and chaired the search for a new president of the California Institute of Technology, culminating in the selection, by the Caltech Board of Trustees, of the Nobelist-biologist David Baltimore.

## **B. Publication list**

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  - l. Thai edition: (Matichon Publishing House, Bangkok, Thailand, 2008)
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8. K. S. Thorne, *The Science of Interstellar* (WW Norton & Company, New York, 2014).
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  - b. Polish edition: (Proszynski I Ska, Warsaw, 2015)
  - c. Russian edition: (Mann, Ivanov, and Ferber, Moscow, 2015)
  - d. Turkish edition: (Alfa Basim Yayim Dagitim, Istanbul, 2015)

- e. Chinese complex edition: (Cheers Publishing Co., Beijing, 2015)
  - f. Chinese simplified edition: (Azoth Books Co., Taiwan, 2015)
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# Institute of Space Sciences

National Spanish Research Council (CSIC) &  
Institute of Space Studies of Catalonia (IEEC)

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Barcelona, July 22nd, 2016

**To:**

Prof. Enrique García-Berro  
Universitat Politècnica de Catalunya  
Departament de Física  
C/ Esteve Terrades, 5  
08860 Castelldefels  
Spain

Dear Prof. García-Berro,

It is a great pleasure to write to you to recommend the nomination of Prof. Kip S. Thorne, the Feynman Professor of Theoretical Physics at the California Institute of Technology (Caltech), as Doctor Honoris Causa of the Technical University of Catalonia (UPC). I have been working for more than twenty years in the field of gravitation and relativistic astrophysics and I can confidently say that Prof. Thorne is one of the most prestigious scientists in this field, at the level of researchers like Stephen Hawking, Roger Penrose, and Martin Rees. Even more important, after the revolutionary discovery of the first direct detection of gravitational waves, announced on February 11th, by the Laser Interferometer Gravitational-Wave Observatory (LIGO, USA), the name that immediately came to our heads is the one of Prof. Thorne. This means that we are talking about a more than likely winner of the Nobel Prize in the next years. The discovery of gravitational waves provides a completely new tool for Astronomy that promises revolutionary discoveries with impact in Astrophysics, Cosmology, and Fundamental Physics, and has been compared to the introduction of the first optical telescopes for astronomical observations. As I am going to describe in this letter, Prof. Thorne has been an exceptional character in all the possible aspects: As a researcher, as a teacher, as a popularizer of science, as well as a colleague.

Prof. Thorne has been a leading figure in Gravitation and in my opinion the main driving force behind Gravitational Wave Astronomy. Based most of his career at Caltech, Prof. Thorne has contributed a lot of work to the theoretical foundations of the field and has promoted many research projects, convincing many other researchers to get involved in the necessary developments to make Gravitational Wave Astronomy a reality. He realized early on of the great potential of laser interferometry and set up an experimental group at Caltech to develop it. He managed to bring Ronald Drever from Glasgow to Caltech, and together with Rainer Weiss (from the Massachusetts Institute of Technology), they were the founders of the LIGO project, pushing it from the early 1980s up to 1992, when the LIGO Cooperative Agreement was signed and the construction began in 1994, funded by the US National Science Foundation. Prof. Thorne has

also participated in very important technological developments that are crucial for the success of LIGO and any other laser-interferometer gravitational-wave detector. He has also been a strong supporter of the Laser Interferometer Space Antenna (LISA), a NASA-ESA project to build a space-based gravitational-wave detector in space, now under ESA lead (the LISA Pathfinder mission of ESA has just demonstrated the readiness of the technology of such detector and the developments will start this same year). Apart from gravitational-wave research he has also authored important developments in relativistic astrophysics: on black holes (together with Stephen Hawking and others), on wormholes, compact star oscillations, numerical relativity, etc.

As the promoter of a new research area, Prof. Thorne has had some of the best possible mentors, among them John Archibald Wheeler, Yakov Borisovich Zel'dovich, and Vladimir Braginsky. But at the same time he has been the mentor of a long list of researchers (52 PhDs), many of them are now world leaders in different areas of research. He has also been an excellent teacher at Caltech. His lectures on Gravitational Waves are very well-known and are available online as they are a reference resource for many PhD students and postdocs. Even more famous is the book he co-authored with Wheeler and Charles Misner, *Gravitation*, a reference for researchers in the field. He always promoted collaboration between institutions and countries. It is specially remarkable his efforts to maintain the collaboration with scientists of the Soviet Union during the difficult coldwar times, a collaboration that everybody acknowledges was very important for several of the developments needed for the construction of LIGO.

Last but not least, I would like to mention that Prof. Kip Thorne has always been very aware of the importance of communicating science to the general public and has always been very active on this front. Apart from giving many popular lectures and writing books, he is very well-known by his recent contribution to the movie *Interstellar*, being the scientific advisor to the film director, Cristopher Nolan, and also playing a central role in the development of some of the black-hole and worm-hole images that appear in the movie. As an example of the impact of this contribution I include the link to a recent article in the newspaper *El País*:

<http://one.elpais.com/kip-thorne-astrofisico-detras-la-ciencia-interstellar/>

For all these reasons, I strongly support the nomination of Prof. Kip S. Thorne for a Doctor Honoris Causa of the Technical University of Catalonia (UPC). I am convinced that Prof. Thorne relevance will only grow in the future as Gravitational Wave Astronomy consolidates as a completely different way of understanding the Universe and people will appreciate more and more his pioneer and leading roles in the field.

Sincerely yours,

r

Carlos F. Sopena  
Institut de Ciències de l'Espai (CSIC-IEEC)

Prof. Dr. Enrique García-Berro  
Departament de Física  
Universitat Politècnica de Catalunya  
c/ Esteve Terrades, 5  
08860 Castelldefels

Barcelona, 13 de juny de 2016

Benvolgut Dr. García-Berro,

És per a mí un honor i un plaer recolzar la proposta del Departament de Física de concedir la menció Doctor Honoris Causa al Dr. Kip S. Thorne del CALTECH. Les raons per donar el meu suport a aquesta proposta són dues. Per una banda, la importància de les contribucions del Dr. Thorne en el camp de la Teoria de la Relativitat General i, sobretot, en el de la detecció de les ones gravitacionals. Per l'altre, la rellevància de la recerca i desenvolupament que es fa en el camp de les ones gravitacionals a la UPC, tant pel que fa als estudis de l'emissió d'ones gravitacionals per col·lisions d'estrelles compactes com a la construcció de sensors per futur observatori d'ones gravitacionals de l'Agència Europea de l'Espai (ESA), la qual cosa fa que aquesta proposta no sigui postissa, producte de la moda actual, sinó que estigui en consonància en unes línies de recerca ben arrelades localment.

El Dr. Thorne, actualment al CALTECH, és famós per les seves contribucions a la física dels forats negres, pels seus treballs sobre els forats de corc a l'espai-temps que potser algun dia ens permetin viatjar en el temps i, sobre tot en la física de les ones gravitacionals i la seva detecció, brillantment confirmades pel projecte LIGO amb el seu anunci de la detecció de la col·lisió de dos forats negres d'una trentena de masses solars cadascun i el rumor (fidedigne) d'una segona detecció que serà publicada ben aviat.

Per totes aquestes raons recolzo amb entusiasme la proposta que s'atorgui al Dr. K. S. Thorne el títol de Doctor Honoris Causa de la Universitat Politècnica de Catalunya.

Cordialment,

Jordi Isern Vilaboy

MAX-PLANCK-INSTITUT FÜR GRAVITATIONSPHYSIK  
ALBERT-EINSTEIN-INSTITUT  
Teilinstitut Hannover

Max-Planck-Institut für Gravitationsphysik  
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To  
Prof. Enrique Garcia-Berro  
Universitat Politecnica de Catalunya  
Departament de Fisica  
c/ Esteve Terrades, 5  
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**Prof. Dr. Karsten Danzmann**  
Direktor

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Hannover, 22.6.2016

**Nomination of Prof. Kip S. Thorne to be become Doctor Honoris Causa of  
the Technical University of Catalonia.**

Ladies and Gentlemen,

I am writing to you today to support the nomination of Prof. Kip S. Thorne for the award of the title Doctor Honoris Causa of the Technical University of Catalonia. There is overwhelming reason to support this honorary nomination. First, Prof. Thorne is the world-leading scientist in his field with an outstanding publication list. Among the many achievements of Prof. Thorne perhaps the most important one is that he laid the grounds for a new kind of science: the science of gravitational waves. He has been one of the founders of the Laser Interferometer Gravitational-wave Observatory (LIGO) that has recently announced the first direct detection of gravitational waves, confirming the last prediction of Einstein's General Theory of Relativity and inaugurating the era of Gravitational Wave Astronomy. It is also highly remarkable that most of Prof. Thorne's theoretical predictions have been ultimately confirmed. Finally, it is very important to realize that Prof. Thorne's research has resulted in seminal contributions to a variety of fields, ranging from Astrophysics to Fundamental Physics.

I enthusiastically support the nomination of Prof. Kip S. Thorne to be become Doctor Honoris Causa of the Technical University of Catalonia.

With best regards,

Prof. Dr. Karsten Danzmann

Director, Max Planck Institute for Gravitational Physics  
Director, Institute for Gravitational Physics, Leibniz Universität Hannover

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MAX-PLANCK-GESELLSCHAFT



Prof. Enrique Garcia-Berro  
Departament de Física Aplicada  
Universitat Politècnica de Catalunya  
c/Esteve Terrades, 5 08860 Castelldefels  
Spain

Trento July 20<sup>th</sup>, 2016

Dear Prof. Garcia-Perro,

Upon suggestion of Dr. Carlos Sopena, I'm writing in support of the nomination of Prof. Kip Thorne to Doctor Honoris Causa at your University.

Obviously I feel almost embarrassed to recommend Prof. Thorne, as his scientific standing worldwide is much higher than mine!

In short summary, in case you have missed this in the international press, Prof. Thorne:

- Is a cofounder of the field of gravitational wave research, together with Prof. Weber of the University of Maryland and Prof. Weiss of MIT
- Is a cofounder of LIGO
- Is the top world expert of the general relativistic theory of gravitational waves
- With probability larger than 99% will be granted the Nobel prize, likely next year, for the first detection of gravitational waves
- Is the only physicist I know that was able to contribute to Hollywood science fiction movies introducing real scientific elements in this powerfully outreaching media (see Interstellar)

I think a detailed letter of recommendation for Kip would take an entire book, but I'm sure the above should convince you that would Prof. Thorne accept your doctorate, this would give a very high exposure to the Universitat Politècnica de Catalunya.

Your faithfully,

Stefano Vitale  
Professor of Physics



# Department of Applied Mathematics and Theoretical Physics

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**To:**  
Prof. Enrique García-Berro  
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**Spain**

Dr. Ulrich Sperhake  
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June 22, 2016

**Concern: Nomination of Kip Thorne,  
Doctor Honoris Causa**

Dear Prof. Gracia-Berro,

I am writing this letter in support of the nomination of Kip Thorne as Doctor Honoris Causa of the Technical University of Catalonia (UPC).

It does not happen frequently that fundamental research dominates the news headlines on the main stream media, but such a remarkable event happened on 11 February 2016, when the first ever detection of gravitational waves was officially announced at a press conference of the LIGO Scientific Collaboration in Washington DC. The breathtaking character of the achievement may fully reveal itself only upon repeated reflection: about 1.3 billion years ago, in the deep past of the universe (multi cellular life was just taking its first steps on Earth around that time), two black holes merged and sent off ripples in spacetime that were measured on 14 September 2015 in the form of length variations of 4 km detector arms by a fraction of a proton radius. The event is a reflection of unimaginable experimental sophistication as much as of ingenious theoretical modeling of the universe we live in. As if this stunning development were not enough, the gravitational wave community could celebrate a second milestone about four months later when, on 7 June 2016, a press conference by the LISA Pathfinder Taskforce announced that this proof-of-concept mission for a space-based interferometer exceeded all expectations in passing key tests in space.

While such scientific projects in their entirety involve thousands of scientists, engineers as well as technical and management staff, there is one name I will forever associate with the amazing human achievement of observing gravitational waves: Kip Thorne. In short, I regard Kip as the father of

gravitational wave astronomy. Kip Thorne's contributions to the field are too numerous and deep to be even summarized without pushing the reader's patience beyond its limits, but it is clear to me to identify the most amazing aspect of his contributions: their all-encompassing nature. Kip Thorne has authored seminal papers on the fundamental theoretical background of gravitational waves, on the astrophysics of gravitational wave sources and on the structure of Einstein's theory of relativity itself. Such results would be sufficient to grace the career of any 20th/21st century physicist, but are only one side of Kip Thorne's contributions to the field. In 1984, he co founded the LIGO project and throughout the decades has been a leading figure in keeping the project on the path that would eventually lead it to global acclaim (and a place in the history books) in February 2016. Over the years, Kip Thorne has provided vital theoretical support for the LIGO project and the LISA space mission which also impacted substantially upon the technical design through determination of the most promising sources, control designs for scattered light in the beam tubes, reduction of thermoelastic noise and optimization of data analysis, to name but a few. As mentioned above, a research effort of such magnitude involves the dedication, expertise and hard work of a large group of people. And yet, without Kip Thorne we would not be where we are: at the dawn of a new era in observational astrophysics and cosmology.

Quite aside from his immediate scientific contributions, Kip Thorne has been a tremendous ambassador of science, both for the public and new generations of researchers. He is, of course, the 'T' in the infamous "MTW" (Misner, Thorne & Wheeler) textbook on General Relativity, but also has inspired the imagination of the wider public through masterly written popular books such as "Black Holes and Time Warps" or his most recent brainchild, the block buster movie "Interstellar". His work has been an inspiration for researchers like myself throughout our careers, but his many outreach activities have sparked my enthusiasm for physics and general relativity during my forming years in a way comparable only to the works of Stephen Hawking and Richard Feynman. In my opinion, Kip Thorne is one of the great scientists of the 20th and 21st centuries.

If there is anything else you would like to ask, please to not hesitate in contacting me.

Yours sincerely,

Sperhake