



Professor Carlos Frenk
Ogden Professor of Fundamental Physics
Durham University
UK

Vice-Chancellor and Warden

KOB/DZ/DB

29 January 2024

World Cultural Council
Case Postale 373
1630 Bulle 2
Switzerland

Dear Members of the Interdisciplinary Committee,

2024 Albert Einstein World Award of Science

It is my pleasure to nominate Professor Carlos Frenk FRS for the 2024 Albert Einstein World Award of Science.

One of the great advances in Physics over the past thirty years has been the development of a “standard model of cosmology”, the so-called “Lambda-CDM” theory, where “Lambda” stands for Einstein’s cosmological constant and CDM for “cold dark matter.” Theoretical predictions made in the 1980s and 1990s were spectacularly corroborated in the 2000s by measurements of the temperature structure of the cosmic microwave background radiation (the heat left over from the Big Bang) and of the clustering of galaxies in space. Carlos and his collaborators played a key role in formulating the predictions for the galaxy distribution. For this, they introduced the then-novel technique of cosmological simulations that has since become a standard, widely-used methodology in theoretical cosmology. Through his work, Carlos and his collaborators have done much to establish cold dark matter as the prime candidate for this as yet unseen but dynamically dominant component of our Universe, encouraging extensive searches for the elementary particles that make up the dark matter. His 1997 paper, with Navarro and White, on the structure of the dark matter clumps in which galaxies form, is the most cited theoretical paper in astrophysics and cosmology of all time.

Carlos has had a major impact on world astronomy. He founded the Institute for Computational Cosmology (ICC) at Durham University, one of the largest and most successful theoretical cosmology groups. This leading centre for cosmological simulations has made major contributions to the modern view of how cosmic structure emerged from the near-uniform primordial soup of the Big Bang. Images and movies from the Virgo Consortium, which Carlos also founded and has led for more than two decades, have done much to shape both the public and the professional perception of how our Universe came to look the way it does and, how our own Milky Way was assembled over the past thirteen billion years.

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Carlos' leadership skills have been instrumental to the success of the ICC. His vision and enthusiasm have been key to attracting significant levels of funding and donations. He has played a major role in securing funding for two buildings that house the Ogden Centre for Fundamental Physics of which the ICC is part. The first, completed in 2002, was opened by the then Prime Minister, The Rt Hon Tony Blair. The second, designed by world-renowned architect Daniel Libeskind (whom Carlos introduced to Durham), was officially opened by Lord Rees of Ludlow in March 2017. Over the years Carlos has generated grant funding to set up the ICC's computational infrastructure and staff appointments and has spearheaded efforts to obtain EU support for international collaborations. Most importantly, Carlos has worked tirelessly to maintain the ICC's high international visibility.

Carlos is extremely well-known and respected internationally. He is one of the most highly cited astrophysicists in the world, having co-authored five of the top hundred most cited papers in the astrophysics literature of all time (of over 1.2 million papers). In 2017, he was made a Commander of the Order of the British Empire (CBE) and was awarded the prestigious Max Born Prize by the German Physical Society. In 2020, he was awarded the Paul Dirac Medal and Prize by the Institute of Physics, and in 2021, the Rumford Medal by the Royal Society. He typically gives half a dozen review talks each year at major international workshops and conferences, and is an exceptional ambassador for the field, frequently giving numerous public addresses and regularly appearing in the media. Since 2019, he has been the Chair of the Royal Society Public Engagement Committee. He has raised the international profile of astronomy and assisted the careers of a generation of young researchers.

Carlos Frenk has dedicated his career to advancing our understanding of cosmology and astrophysics. His major contributions and breakthroughs in discovery and knowledge are internationally recognized and will stand the test of time. He is an eminent scientist whose achievements in scientific and technological research, in the promotion of science to the public, and in inspiring and training a large number of young scientists has brought true benefit to mankind. He is at the pinnacle of his field, and his many remarkable achievements make him a leading contender for the Albert Einstein World Award of Science. I am delighted to recommend to you, Professor Carlos Frenk, as our nominee for the World Cultural Council's 2024 Albert Einstein World Award of Science.

Yours faithfully,



Professor Karen O'Brien
Vice-Chancellor and Warden



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22 January 2024

Albert Einstein World Award of Science Committee

Re: -Letter of support for Carlos Frenk's nomination for the Albert Einstein World Award of Science

Dear Panel,

I have known Carlos Frenk since the 1970s, when he came from Mexico to become a Research Student in Cambridge and I have followed his career with admiration.

One of the growth points in current astronomy – indeed one of the highlights of physical science generally – is the delineation of how the structure of our universe originated and evolved. Improved evidence from cosmic microwave background anisotropies) has dramatically firmed up our knowledge of initial fluctuations, and the proportions of baryons and dark matter in the universe. It's surely a great triumph is that, starting from these observed 'initial conditions' when the universe was 0.00003 of its present age, computer simulations have been able to show how the galaxies and clusters in our present universe emerged, vindicating a 'standard model' of cosmology.

Carlos is an acknowledged leader in this subject, not only within the UK but throughout the world. He was in the 1980s one of the pioneers in investigating the cold dark matter (CDM) model – now the 'standard paradigm' in cosmology. Along with two outstanding colleagues, Simon White in Munich and George Efstathiou in Cambridge, he managed to ensure that this is an area where leadership comes from this side of the Atlantic.

He is author or co-author of many of the most influential recent papers aiming to understand how galaxies formed, how they evolve, and how they are grouped into clusters. This work involves numerical simulations, plus the use of large data-samples gained by optical astronomers, plus measurements of cosmic x-rays and gamma-rays gas (made from orbiting satellites)

Even if one grants all the inadequacies of bibliometric data, it certainly counts for something that he's one of the most cited UK authors in any of the physical sciences. At least equally important, however, has been his contribution as an inspiring leader. He has nurtured, attracted and retained an extraordinarily high-quality group of younger colleagues. The fact that the international profile of Durham Astrophysics is extremely high, despite its resources being modest compared with leading centres in the US or mainland Europe, is in large measure due to his personality and intellectual leadership. His efforts were pivotal in securing the combination of private and government funds which have enabled Durham to set up the Ogden Centre for Computational Physics and Astrophysics – and he persuaded Libeskind to design his new building!



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Carlos has a high profile in his subject worldwide, not just parochially in the UK. He is a charismatic and hyper-energetic man who has a dynamic and constructive influence on astronomy by focusing on really important problems, relating closely to observers, and having the stamina to pursue large-scale and long-term projects. His achievements will certainly rank high when the history of astronomy in these decades is written.

It's, of course, his research achievements that render him an exceptionally strong candidate for the Albert Einstein World Award of Science – and I know several previous winners so I am aware of the level of distinction expected. But it is perhaps appropriate to mention all he's done as an 'ambassador' for his subject internationally. As an ex-president of the Royal Society, I can testify to his energetic work as a Council member, etc. Moreover, he has been immensely successful in interacting with the general public. He is a superb lecturer and broadcaster, and 3-D movies based on his group's simulations have been a highlight of many UK exhibitions.

For the reasons summarized in this letter, I warmly and enthusiastically endorse this nomination.

Yours sincerely

Martin Rees

Prof Lord Rees of Ludlow, OM, FRS
Astronomer Royal
mjr36@cam.ac.uk



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January 26, 2024

Selection Committee

Dear Colleagues,

It is my pleasure to support the nomination of *Carlos Frenk* for the 2024 Albert Einstein World Award of Science, to recognize his pioneering contributions to the theory of galaxy and structure formation in a cold dark matter universe and the application of large scale structure as a probe of fundamental physics. Carlos and his long-time collaborator Simon White are the two leading founders of the modern theory of galaxy formation, with wide ranging contributions that encompass analytic theory, powerful and innovative supercomputer simulations, and sophisticated comparisons to observational data. White's contributions were recognized by the 2017 Shaw Prize in Astronomy, but Frenk's contributions have not been recognized by a comparable award, although he has also received numerous prestigious honors.

The modern approach to the theory of large scale structure traced by the 3-dimensional clustering of galaxies was established in a series of papers in the late 1980s by the "gang of four," most famously *The evolution of large-scale structure in a universe dominated by cold dark matter* by Davis, Efstathiou, Frenk, & White (1985). These papers (nine in total) took then nascent ideas of non-linear structure formation from primordial fluctuations imprinted by inflation on a universe dominated by weakly interacting massive particles and turned them into a quantitative, predictive theory, by means of what were then the world's most powerful cosmological simulations. Many of the key ideas of large scale structure and galaxy formation are worked out in these papers, including creation and normalization of initial conditions, methods for populating simulations with galaxies that allow for bias between galaxies and dark matter, comparison to measurements from galaxy redshift surveys using correlation functions and other clustering statistics, and, in the later papers, resolving the formation of galactic scale dark matter halos and using them as a way to locate galaxies and assign them physical properties. The empirical success of the cold dark matter (CDM) scenario presented in these papers was more impressive and convincing because White, Frenk, & Davis (1983) had used similar techniques to rule out an earlier cosmological model, in which massive neutrinos were the dominant form of dark matter.

From these remarkable early achievements, Carlos has moved forward in many directions, towards higher numerical resolution and detail in dark matter clustering, towards adding sophisticated physical treatments of galaxy formation, towards ever more powerful suites of cosmological simulations, and towards more wide ranging and stringent tests of theory against observations.

On the first of these themes, the single most important discovery was that dark matter halos formed by gravitational collapse of collisionless dark matter exhibit a "universal" density

profile that bends slowly from r^{-1} in the central regions to r^{-3} in the outer regions. The paper describing this “NFW profile” (Navarro, Frenk, & White 1997) is *the most highly cited theoretical astrophysics article of the past three decades*, reflecting its broad implications for the dynamics and structure of galaxies and for the nature and detectability of dark matter. The high central densities of NFW halos predict rotation curves and stellar dynamics in significant tension with observations of low mass galaxies, as already noted in NFW’s first papers. Work by several groups, beginning with Navarro, Eke, & Frenk (1996), suggests that this tension may be resolved in galaxy formation models with vigorous stellar feedback, which creates fluctuations in the baryon potential that in turn stir up the dark matter. The viability of this solution remains a matter of lively debate, and the discrepancy with NFW predictions may yet prove to be the signature of dark matter self-interactions or some other profound departure from CDM. On the larger scales of galaxy clusters, gravitational lensing observations generally show good agreement with NFW predictions, though the central profile slope remains difficult to measure in the presence of baryon components. Carlos’s other influential papers on this theme include studies of the halo mass function and studies of the gravitationally bound subhalos that orbit within their larger parent halos.

Turning to galaxy formation physics, Carlos co-founded the field of semi-analytic galaxy formation theory (White & Frenk 1991), and he has pushed the field forward with many collaborators (Shaun Cole, Richard Bower, Andrew Benson, Carlton Baugh, Cedric Lacey) over many years. Semi-analytic models give critical insight on the physical processes that determine the properties of galaxies, and they create a quantitatively predictive theory that can be tested against observed galaxy properties over the full history of the universe to constrain these physical processes and the nature of dark matter and primordial fluctuations. They are especially powerful in conjunction with large dark matter simulations that trace the merger histories of halos. Carlos’s many collaborative papers on this theme established the current understanding that the efficiency of galaxy formation — the ratio of a galaxy’s stellar mass to the baryonic mass of its host halo — is regulated primarily by photoionization in the lowest mass halos, by stellar feedback in intermediate mass halos, and by black hole feedback in the most massive halos. In an innovative extension of this numerical+semi-analytic approach, Cooper et al. (2010) used the ultra-high resolution Aquarius N-body simulations to predict the properties of galactic stellar halos created by the disruption of infalling dwarf galaxies, predictions that can be tested in detail against observations from giant stellar spectroscopic surveys and astrometry from the *Gaia* mission.

The other approach to galaxy formation physics is to incorporate hydrodynamics, star formation, and feedback directly into cosmological simulations. Carlos was a founder and long-time PI of the Virgo Consortium, which has carried out many of the most powerful N-body and hydrodynamic simulations over a wide range of scales, building extraordinary, innovative numerical simulation tools along the way. In addition to the Millenium N-body simulation, two of the most influential simulation suites by the Virgo consortium are the EAGLE simulations of large cosmological volumes and the APOSTLE simulations that zoom in to scales of the Local Group and dwarf galaxies. Many remarkably talented researchers have made essential contributions to these simulations and their applications. Carlos has played the largest role in creating the collaboration environment that made them possible, including putting enormous effort into obtaining and managing the computational resources that have kept Virgo at the leading edge of numerical cosmology for nearly three decades.

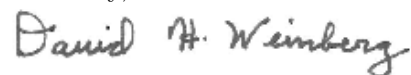
From the gang-of-four papers onward, Carlos has been a leader in using large scale structure and galaxy clusters to constrain cosmological parameters. White et al. (1993) was for me the most convincing early demonstration that the cosmic mean matter density was well below the

critical density. White, Efstathiou, & Frenk (1993) remains the most lucid explanation of how the abundance of galaxy clusters constrains the amplitude of matter fluctuations, a topic still at the forefront of cosmology because of the “S8 tension” in the standard cosmological model. Under Carlos’s leadership, Durham University took on major roles in the 2dF Galaxy Redshift Survey, the Galaxy and Mass Assembly (GAMA) redshift survey, and now the Dark Energy Spectroscopic Instrument (DESI). Although this work was most directly led by others, Carlos’s background efforts have been essential to enabling it, and he has contributed many critical ideas to the design, execution, analysis, and interpretation of these surveys. One highlight of this work is the final power spectrum analysis of 2dF (Cole et al. 2005), which derived the cosmological constraints from what was then the world’s largest galaxy redshift survey. Together with Eisenstein et al. (2005), based on the SDSS, Cole et al. (2005) presented the first clear observational detection of baryon acoustic oscillations (BAO). BAO measurements have since become a critical tool for testing theories of dark energy and cosmic acceleration, and they are a primary motivation for the galaxy redshift surveys of DESI and the ESA *Euclid* mission. Carlos remains deeply engaged in applying galaxy clustering and gravitational lensing to derive cosmological parameters, measure neutrino masses, and test the cold dark matter hypothesis (e.g., He, Li, Frenk et al. 2022).

This account only scratches the surface of Carlos’s many foundational contributions to the understanding of dark matter, galaxy formation, and large scale structure. Alongside his publications, Carlos has shaped the field as a truly extraordinary builder of institutions and mentor of younger scientists. He built Durham into the world’s leading institution for numerical cosmology and galaxy formation, with a unified theoretical and observational research program that runs from the dynamics and chemical abundances of Milky Way stars to the properties of the first galaxies to the fluctuations of the cosmic microwave background. In addition to a research powerhouse, he has made Durham a center for outreach, bringing the thrill of cosmological discovery to the public at large.

As noted in the c.v., Carlos’s citation statistics are off the charts, reflecting the almost unbelievable breadth of his highly influential work. Only Jim Peebles, Yakov Zeldovich, and Simon White have made comparably important contributions to our theoretical understanding of the origin of cosmic structure. Carlos’s accomplishments have been recognized with honors that include the 2011 Gruber Cosmology Prize to the “gang of four,” the George Darwin Prize of the Royal Astronomical Society (2010), the Rumford Medal of the Royal Society (2021), and many others (see c.v.). Among astrophysicists, Carlos is an especially apt choice for the World Cultural Council’s World Award of Science because alongside his groundbreaking scientific contributions spanning more than four decades, he has made outstanding contributions in building scientific institutions and collaborations and in promoting science to the broader community. The Durham Institute for Computational Cosmology and the international Virgo Collaboration have been two of the most influential actors in theoretical cosmology over the last 30 years; Carlos is *the* driving force behind the first and one of the two or three most important leaders of the second. Carlos is also tireless in his efforts to bring astronomical discoveries to the general public, and I suspect that he is the professional astronomer heard most often on the UK airwaves.

Sincerely,

A handwritten signature in dark ink, reading "David H. Weinberg". The signature is written in a cursive, slightly slanted style.

David H. Weinberg
Distinguished University Professor and Chair of Astronomy

RESUME OF ACHIEVEMENTS

Professor Carlos Frenk, FRS

He is a Mexican-British-German cosmologist with primary interests in the field of cosmology, galaxy formation and computer simulations of cosmic structure formation. He is the Ogden Professor of Fundamental Physics and founding Director of the Institute for Computational Cosmology at Durham University, UK.

Carlos Frenk was born in Mexico City in 1951, the son of a Mexican pianist and chemist and a German doctor who had fled to Mexico as a child before World War Two. He gained the top marks in his class for the Physics Degree at the National Autonomous University of Mexico in 1976. He obtained his PhD in Astrophysics at Cambridge University and carried out postdoctoral work at the University of California, in Berkeley and Santa Barbara, and at the Universities of Sussex and Cambridge. He was appointed Lecturer in Physics at the University of Durham in 1985, became Professor of Physics in 1993 and was appointed Ogden Professor in 2001. He was elected a Fellow of the Royal Society in 2004 and was one of the recipients of the \$500,000 Gruber Prize in Cosmology in 2011.

Carlos Frenk is one of the originators of the Cold Dark Matter theory for the origin of galaxies and other cosmic structures. His series of papers with Davis, Efstathiou and White in the 1980's established that the Cold Dark Matter model could reproduce the observed abundance and large-scale distribution of galaxies in considerable detail. His papers with Navarro and White in the 1990s established that dark matter halos, the fundamental units of all nonlinear structures in the Universe, should have a universal density structure. This has since been verified through gravitational lensing and X-ray observations of galaxy groups and clusters and has become the standard model of dark matter halo structure. His more recent papers with his Durham group (Cole, Lacey, Baugh and others) over the last 15 years have created a world-leading capability for predicting the observable properties of galaxies in a Cold Dark Matter universe. Overall, Frenk has pioneered many of the developments that have resulted in the Cold Dark Matter model becoming accepted as the standard paradigm for cosmic structure formation. His many other contributions to cosmology include the execution and analysis of large galaxy redshift surveys, most notably the Anglo-Australian Two Degree Field Redshift Survey and, currently, the Dark Energy Spectroscopic Survey.

Carlos Frenk is also responsible for the creation of the Institute for Computational Cosmology at Durham University, which he has directed since its foundation until 2001 and has become a world-leading Centre for supercomputer simulations of cosmic structure formation. He and his research group carry out large cosmological simulations of the evolution of the Universe using the 'Cosmology Machine' at Durham University, one of the largest supercomputers in the UK, which Frenk was instrumental in bringing to Durham. Since 1996, he has been the Principal Investigator of the Anglo-German 'Virgo Consortium', an international collaboration responsible for the largest and most sophisticated cosmological simulations in the world. He is also involved in the execution and analysis of large surveys of galaxies in our cosmic neighbourhood that are used to test the predictions of cosmological theory.

During his illustrious career to date, Carlos has received many honors, distinctions and awards in recognition of his achievements. In the past ten years alone, he has received the: Rumford Medal of the Royal Society (2023), Paul Dirac Medal and Prize, Institute of Physics (2021), Max Born Prize German Physical Society (2017), the Gold Medal of the Royal Astronomical Society (2014); Oort Professorship, Leiden, Netherlands (2014);

Alexander von Humboldt Research Award (2013); The Gruber Cosmology Prize (2011); Hoyle Medal and Prize, Institute of Physics (2010); George Darwin prize, Royal Astronomical Society (2010). He was made a Commander of the British Empire (CBE) in the 2017 Queen's Birthday list and elected an Honorary Fellow of King's College, Cambridge, in 2023.

Carlos Frenk currently has over 560 publications in the refereed scientific literature that have accrued a total of more than **122,627** citations. His H-index is currently 154, one of the highest in the world. Eighteen of his papers have more than 1000 citations. The following include some of his most highly cited work:

- A Universal Density Profile from Hierarchical Clustering, ApJ 490,493 (1997) 8721+ *cits*
- The Structure of Cold Dark Matter Halos, ApJ 462, 563 (1996) 7106+ *cits*
- Simulations of the formation, evolution and clustering of galaxies, Nature 435,629 (2005) 3892+ *cits*
- The evolution of large-scale structure in a universe dominated by CDM, ApJ 292,371 (1985) 3168+ *cits*
- The many lives of active galactic nuclei, MNRAS 365,11 (2006) 3219+ *cits*
- Breaking the hierarchy of galaxy formation MNRAS 370,645 (2006) 2088+ *cits*
- Galaxy formation through hierarchical clustering ApJ, 379, 52 (1991) 2103+*cits*
- The 2dF Galaxy Redshift Survey: spectra and redshifts, MNRAS 328, 1620 (2001) 1723+ *cits*
- Hierarchical galaxy formation MNRAS 319, 168 (2000) 1690+ *cits*
- The EAGLE project: simulating the evolution and assembly of galaxies and their environments MNRAS 446, 521 (2015) 2733+ *cits*

Carlos Frenk's drive, determination, and commitment to his field have underpinned his ability to raise significant levels of funding from both national (e.g. Research Councils) and international (e.g. EU) sources. Such funding, in the order of several tens of millions of pounds, has allowed him to extend his research, train a new generation of scientists and invest in infrastructure. Large amounts of capital have been raised on the back of Frenk's achievements from philanthropic organisations, leading to the construction of two new buildings dedicated to astrophysics, cosmology and particle physics, including a landmark building designed by world-renowned architect Daniel Libeskind.

Carlos Frenk is a devoted teacher. He has delivered various undergraduate and postgraduate courses in Physics and Astrophysics. He has trained over 50 PhD students and over 50 postdoctoral research assistants, the majority of whom have subsequently gone on to establish successful research careers in astronomy, often in highly prestigious posts. Frenk is a true inspiration to the field.

Carlos Frenk also dedicates a significant amount of time and effort to ensure that the outcome and impact of his work are shared and understood, particularly in the broader application and public understanding. He plays an active role in the dissemination of astronomy and cosmology through the media on both the national and international stages. He gives frequent public lectures and, in addition to radio interviews, he has appeared on numerous TV programmes, from the BBC's Sky at Night to Horizon and Newsnight, and on international TV channels around the world. He and his Durham group have produced celebrated movies of the evolution of the cosmos, which have been shown around the world including at the Royal Society's Summer Science Exhibition in London. He has been the Chair of the Royal Society Public Engagement Committee since 2019.

Curriculum Vitae: Carlos S. Frenk

(January 2024)

Personal Details:

Name: Carlos S. Frenk **Nationality:** Mexican, British & German
Address: Institute for Computational Cosmology (44 191) 3343641
Ogden Centre, Physics Department (44 191) 3343635 (secretary)
University of Durham (44) 7808 726080 (mobile)
Durham DH1 3LE, England C.S.Frenk@durham.ac.uk

Academic Record:

Dates	Degree	Place
1977-1981	PhD (Astronomy)	University of Cambridge
1976-1977	Maths Tripos Part III (Honours)	University of Cambridge
1972-1976	BSc Theor. Physics (Top marks in year)	University of Mexico

Employment:

Dates	Position	Institution
2001-present	Ogden Professor of Fundamental Physics	University of Durham
2001-2020	Director, Institute for Computational Cosmology	University of Durham
1985-2001	Lecturer, Reader (1991), Professor (1993)	University of Durham
1983-1985	Postdoctoral Research Fellow	University of Sussex
1983-1985	Assistant Research Physicist	University of California, Sta. Barbara
1981-1983	Postdoctoral Research Fellow	University of California, Berkeley

Fellowships, awards and distinctions:

Year	
2023	Honorary Fellow of King's College, Cambridge
2023	Honorary Fellow of Cambridge Philosophical Society
2021	Rumford Medal, Royal Society
2020	Paul Dirac medal and prize, Institute of Physics
2020	Clarivate Web of Science Citation Laureate (2020)
2019	Honorary Doctor of Science, Sussex University
2017	Commander of the Order of the British Empire (CBE)
2017	Max Born Prize German Physical Society (DPG)
2017	Elected member of the Mexican Academy of Sciences
2014	Oort Professorship, Leiden Observatory, the Netherlands
2014	Gold medal, Royal Astronomical Society
2013	Alexander von Humboldt Research Award
2013	Lansdowne Visitor, UVic, Canada
2013	The Biermann Lectures, Max Planck Society
2011	The Gruber Cosmolgy Prize (\$500,000, jointly w. M. Davis, G. Efstathiou, S. White)
2010	Hoyle Medal and Prize, Institute of Physics
2010	George Darwin prize, Royal Astronomical Society
2007	Daniel Chalonge medal, Observatoire de Paris
2006	Royal Society Wolfson Research Merit award
2006	The Withrow lecture, Royal Astronomical Society
2004	Elected Fellow of the Royal Society
2004	Ranked 2 th most cited author in Space Sciences in the world in the past 10 years.
2002	Ranked 5 th most cited physical scientist in UK since 1980
2000-2001	Leverhulme Research Fellowship
2000	Ranked 16 th most cited physical scientist in the UK during the 1990s
1996-1999	PPARC Senior Fellowship
1992-1993	Sir Derman Christopherson Fellowship, University of Durham
1991-1992	Nuffield Foundation Science Research Fellowship
1985	SERC Advanced Fellowship (declined)
1976-1979	British Council Fellowship
1976	<i>Gabino Barreda</i> medal for first place in Theor. Phys. degree

Publications, citations, etc.

- 568 refereed papers in the scientific literature; 206 non-refereed
- Over 122,569 times (H-index 154): one of most cited authors in astronomy and space science in the world
- Author of 5 of the 100 most cited papers ever published in astronomy and space science
- 2020 Clarivate Web of Science Citation Laureate: ranked 97 in the world and 7 in UK in Physics
- 245 invited talks at major international conferences
- Supervised 50 PhD students (45 graduated so far) and 50 postdoctoral researchers
- Included in “The world’s most influential scientific minds, 2015” by Thomson Reuters’.

Research grants and other income

- Since 1985, research grants of £81.0 M (in 2017 pounds) as PI: £68.9 M from UK and £12.1 M from EU
- Raised £7,370,000 from philanthropic organizations (for two new buildings and PhD studentships).

Academic leadership

- Helped build up astronomical research at Durham, with the group growing from fewer than 10 astronomers and astrophysicists when I arrived in 1985 to over 150 today
- Founded the Institute for Computational Cosmology (ICC) in 2001 and was Director until 2020. I was head of the “Theory Group” (1986-2001) and Head of Astronomy (2002-2007). The ICC is one of the leading institutions in the world for research on the structure of the Universe. It employs over 60 scientists and technicians who build model universes using powerful supercomputers to understand how our Universe evolved from simple beginnings to its present day complexity characterized by myriads of stars and galaxies.
- Led two major fundraising campaigns (from philanthropic organizations, government and Durham University) for two buildings to house the ICC and the Institute for Particle Physics Phenomenology. The first (1998-2000; with M. Pennington and J. Sterling) was for the Ogden Centre East building and the second (2012-2014) for the Ogden Centre West. Introduced world-renowned architect Daniel Libeskind to Durham, and this led to his successful bid for the design of the second building which was opened in March 2017.

Committees

- Have served on 11 Research Council committees, 9 Royal Society committees (including Council during 2012-15 and 2023 -) and 10 foreign committees, including the Kavli Prize for Astrophysics selection panel. Since Jan/2021, I have been Chair of Royal Society Public Engagement Committee. Since Jan/2022 I have been Chair of Panel 9 of the ERC Advanced Investigator Grants committee.

Public outreach

- Initiated (with J. Sterling and I. Smail) a programme of public outreach at Durham, focused on the evolution of the Universe, reaching tens of thousands of school children in the Northeast
- 128 public lectures, including 18 named lectures
- Have appeared on TV in numerous occasions: 32 times on the BBC (Horizon, Sky at night, news, etc), 12 times on other UK channels (Channel 4, ITV, etc) and 16 times on foreign channels (in the USA, Germany, France, Italy, Spain, Argentina, Australia, Japan, Mexico). I have appeared on radio on 63 occasions, including 42 on the BBC radio and on several foreign stations (Canada, Argentina, Spain, Mexico, China).

Recent research grants as PI

Dates	Title	Awarding Body	Amount (£)
2008-2013	The Formation of Cosmic Structure (rolling grant)	STFC	3,105,567
2009-2012	High Performance Computing: Virgo	STFC	1,654,047
2009-2013	Cosmocomp Initial Training Network	EC	3,465,385
2011-2014	Visiting Fellows at Durham	STFC	90,531
2011-2015	Latin Am., China, Eur. Gal. Form. Network (LACEGAL)	EC	202,217
2011-2016	ERC Advanced Investigator Grant (From the Milky Way to the large-scale structure)	European Res. Coun.	€1,935,800
2011-2015	The Formation of Cosmic Structure (rolling grant)	STFC	2,639,340

2012-2016	The Durham DiRAC-2 petascale facility	STFC	3,700,000
2014-2017	Durham Consolidated Grant £7.4M (all Durham)	STFC	2,634,040 (ICC)
2015-2018	Newton Advanced Fellowship	Royal Society	111,000
2017-2018	The Durham DiRAC-2.5x Memory Intensive	STFC	2,128,952
2017-2020	Durham Consolidated Grant £7.4M (all Durham)	STFC	2,200,000 (ICC)
2017-2020	The Durham DiRAC-2.5 Operations	STFC	567,548
2018-2024	ERC Advanced Investigator Grant (The identity of the dark matter)	European Res. Coun.	€2,493,439
2020-2023	Durham Consolidated Grant £5.95M (all Durham)	STFC	1,350,000 (ICC)
2017-2021	DiRAC-2.5 operations	STFC	2,115,359
2019-2022	DiRAC-3 computer and operations	STFC	7,148,944
2022-2023	DiRAC-3 operations extension	STFC	4,449,000
2023-2026	DiRAC-3 operations	STFC	2,105,000

Other fund raising

Dates	Purpose	Source	Amount (£)
2014	New Building for Ogden Centre	Wolfson Foundation	1.5M
2013	New Building for Ogden Centre	Ogden Trust	3.32M
2013	New Building for Ogden Centre	Fund raising campaign	90,000
2001	Building for Ogden Centre for Fundamental Physics	Ogden Trust	2.2M
2002	Sculptures by Peter Robinson for Ogden Centre	de Laszlo/Hefner	confidential
2005-	Research support	de Laszlo Foundation	117,000
2011-2027	PhD studentships	Undisclosed	320,000

Recent invited talks at major international conferences

Date	Conference	Lecture/review
2019	Small galaxies, cosmic questions, Durham	Dwarfs: the giants of cosmology
2019	Dutch Astroparticle Symposim, Wijk aan Zee	Distinguishing CDM from other models
2019	Polish Astronomical Society meeting, Olsztyn	Tests of the cold dark matter paradigm
2019	Dark side of the Universe, Buenos Aires	A conclusive test of cold dark matter
2019	1 st Shanghai Assembly Cosm. & Gal. Form,	Astrophysical tests of the identity of dark matter
2019	Festkolloquium for Simon White, MPA Garching	The birth of CDM and its current health
2020	Identification of dark matter, Vienna (online)	Simulations of a CDM universe
2020	Congress Mexican Phys Soc., Mex. City (online)	A definitive test of cold dark matter: no ifs or buts
2020	Opening Mesoam Inst Sc. Chiapas, Mex (online)	The formation of structure in the Universe
2020	Latin Am. Work. Obs Cosm, Sao Paolo (online)	A conclusive test of the cold dark matter model
2022	Comp. gal. form., Ringberg Castle, Germany	Miscalculations in simulations of Galactic satellites
2022	Virgo meeting, Garching, Germany	A short history of Λ CDM
2022	IDM22 Vienna	Dark Matter Halo Simulations/Observations
2023	Nicolaus Copernicus World Congress, Torun, Poland	The cold dark matter model
2023	Observing the evolving universe, London	A conclusive test of LCDM
2023	Nobel Symposium on dark matter, Stockholm, Sweden	A definitive test of the cold dark matter hypothesis
2023	Fiat Lux, Castelgandolfo, Italy	A conclusive test of cold dark matter
2023	Cosmology 2023 in Miramare, Trieste Italy	A conclusive test of cold dark matter
2023	550 Years of the Copernican Universe, Berlin, Germany	The emergence and prospects of the standard model

Recent named public lectures

Date	Event	Lecture
2013	The Lansdowne Lecture, U of Victoria, Canada	Everything from nothing
2015	The 2nd Wetton Lecture, Oxford Univ.	How our universe was made
2015	The Oort Lecture, Leiden Univ.	Cosmic origins
2019	Master Distinguished Lecture, Shanghai	Everything from nothing
2022	The Brinson Lecture, Chicago	How our Universe was made
2022	Global lectures, Durham University, London	Cosmic Extinction: the far future of our Universe
2022	The Misel Family Lecture, Minneapolis	How our Universe was made

Carlos S. Frenk - 10 most significant publications

Generally, collaborating PhD students and postdocs are placed at the top of the author list. The numbers in brackets at the end of each entry are the citations for each paper to date. All papers may be accessed at <https://ui.adsabs.harvard.edu/>.

Refereed publications: **569**; total number of citations **122,585**; H-index **154**

1. Navarro, J. F., Frenk, C. S., & White, S. D. M. 1997, *A Universal Density Profile from Hierarchical Clustering*. *Astrophys. J.*, 490, 493. [8718]
2. Springel, V., White, S. D. M., Jenkins, A., et al. 2005, *Simulations of the formation, evolution and clustering of galaxies and quasars*. *Nature*, 435, 629. [3891]
3. Davis, M., Efstathiou, G., Frenk, C. S., & White, S. D. M. 1985, *The evolution of large-scale structure in a universe dominated by cold dark matter*. *Astrophys. J.*, 292, 371. [3167]
4. Schaye, J., Crain, R. A., Bower, R. G., et al. 2015, *The EAGLE project: simulating the evolution and assembly of galaxies and their environments*. *Mon. Not. R. astr. Soc.*, 446, 521. [2731]
5. White, S. D. M., & Frenk, C. S. 1991, *Galaxy Formation through Hierarchical Clustering*. *Astrophys. J.*, 379, 52. [2103]
6. Bower, R. G., Benson, A. J., Malbon, R., et al. 2006, *Breaking the hierarchy of galaxy formation*. *Mon. Not. R. astr. Soc.*, 370, 645. [2088]
7. Cole, S., Percival, W. J., Peacock, J. A., et al. 2005, *The 2dF Galaxy Redshift Survey: power-spectrum analysis of the final data set and cosmological implications*. *Mon. Not. R. astr. Soc.*, 362, 505. [1723]
8. Cole, S., Lacey, C. G., Baugh, C. M., & Frenk, C. S. 2000, *Hierarchical galaxy formation*. *Mon. Not. R. astr. Soc.*, 319, 168. [1690]
9. Springel, V., Wang, J., Vogelsberger, M., et al. 2008, *The Aquarius Project: the subhaloes of galactichaloes*. *Mon. Not. R. astr. Soc.*, 391, 1685. [1594]
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Carlos S. Frenk - Refereed publications

The numbers in brackets at the end of each entry are the citations to date.

All papers may be accessed on <https://ui.adsabs.harvard.edu/>

Number of refereed papers: 569 Total citations: 122,627 H-index -154

- Nightingale, J. W., He, Q., Cao, X., et al. 2024, *Scanning for dark matter subhaloes in Hubble Space Telescope imaging of 54 strong lenses*. Mon. Not. R. astr. Soc., 527, 10480. [0]
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- Adame, A. G., Aguilar, J., Ahlen, S., et al. 2024, *Validation of the Scientific Program for the Dark Energy Spectroscopic Instrument*. Astron. J., 167, 62. [43]
- Chan, T. K., Benítez-Llambay, A., Theuns, T., Frenk, C., & Bower, R. 2024, *The impact and response of mini-halos and the inter-halo medium on cosmic reionization*. Mon. Not. R. astr. Soc., [4]
- Kugel, R., Schaye, J., Schaller, M., et al. 2023, *FLAMINGO: calibrating large cosmological hydrodynamical simulations with machine learning*. Mon. Not. R. astr. Soc., 526, 6103. [11]
- McCarthy, I. G., Salcido, J., Schaye, J., et al. 2023, *The FLAMINGO project: revisiting the $S₈</SUB>$ tension and the role of baryonic physics*. Mon. Not. R. astr. Soc., 526, 5494. [2]
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