

*Curriculum Vitae*  
**Duncan Steel** BSc(Hons), MSc, DIC, PhD, FRAS

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**Tertiary Education:**

Doctor of Philosophy, Department of Physics and Astronomy, University of Canterbury, New Zealand, 1982-1985 (thesis entitled *Orbital Characteristics of Meteoroids* submitted in September 1984).

Graduate work in Planetary Science, Atmospheric Physics and Aeronomy, University of Colorado at Boulder, USA, 1979-81.

Master of Science (and college diploma) in Applied Optics, Imperial College of Science and Technology, University of London, 1978-1979.

Graduate work in Astrophysics, Queen Mary College, University of London, 1977-78.

Bachelor of Science with Combined Honours in Physics and Astrophysics, Queen Elizabeth College (now a part of King's College), University of London, 1974-1977.

**Open source of personal information:** [http://en.wikipedia.org/wiki/Duncan\\_Steel](http://en.wikipedia.org/wiki/Duncan_Steel)

**Employment History:**

May–June 2014: Visiting Research Scholar, Department of Physics and Astronomy, University of Western Ontario, Canada

August 2013 onwards: Visiting Astronomer, Armagh Observatory, Northern Ireland

May 2013 onwards: Visiting Professor of Astrobiology, University of Buckingham, UK

April 2013 onwards: Visiting Space Scientist, NASA-Ames Research Center, California

April 2012 onwards: self-employed space researcher and author

July 2004-March 2012: Principal Research Scientist, QinetiQ Proprietary Limited (formerly Ball Aerospace Australia), Canberra.

January 2004-November 2012: Visiting Researcher, Australian Centre for Astrobiology, University of New South Wales (but formerly located at Macquarie University).

January 2004-July 2009: Member of the Advisory Committee, Adelaide Festival of Ideas.

September 2003-July 2004: Media consultant, making various radio & TV programmes, plus writing for the print media.

August 1999-August 2003: Reader (Associate Professor) in Space Technology, University of Salford, England; on the *Wikipedia* webpage for the university ([http://en.wikipedia.org/wiki/University\\_of\\_Salford](http://en.wikipedia.org/wiki/University_of_Salford)) I am listed as one of just ten *Notable Academics* who have worked there.

May-July 1999: Senior Research Fellow, Armagh Observatory, Northern Ireland.

March 1996-February 1998 and 2002-2006: Vice-President, the Spaceguard Foundation (which is located at the European Space Research Institute, Frascati, Italy):  
[http://en.wikipedia.org/wiki/Spaceguard\\_Foundation](http://en.wikipedia.org/wiki/Spaceguard_Foundation)  
[http://www.esa.int/SPECIALS/NEO/SEMS58OVGJE\\_o.html](http://www.esa.int/SPECIALS/NEO/SEMS58OVGJE_o.html)

December 1992-August 1999: Director, Spaceguard Australia Pty Ltd, Adelaide.

April 1991-December 1996: Senior Research Fellow, Department of Physics and Mathematical Physics, University of Adelaide, South Australia.

April 1991-December 1995: Senior Research Astronomer, Anglo-Australian Observatory, Coonabarabran, New South Wales, Australia.

Mid-1988 through 1996: Various extended periods (generally austral winters) spent as a visiting research scientist at:

- Solar System Exploration Branch, NASA-Ames Research Center, California;
- Department of Astrophysics, University of Oxford;
- Unit for Space Sciences and Astrophysics, University of Kent at Canterbury.

November 1988-November 1992: Company Director and Head of Research, Spaceguard Pty Ltd, Adelaide.

February 1989-April 1991: Australian Research Council Research Fellow, Department of Physics, University of Adelaide.

February 1987-February 1988: European Space Agency Research Fellow, Institutionen för Astronomi, Lunds Universitet, Sweden.

January 1985-January 1987 and February 1988-February 1989: Australian Research Council Research Associate, Department of Physics, University of Adelaide.

February 1982-December 1984: Teaching Fellow and Lecturer, Department of Physics and Astronomy, University of Canterbury, New Zealand.

January 1980-January 1982: Consultant in Planetary Sciences, Atmospheric Sciences Division, (U.S.) Universities Space Research Association.

September 1979-January 1982: NASA-funded Research Assistant, Laboratory for Atmospheric and Space Physics, University of Colorado at Boulder, USA.

August 1977-August 1978: Tutor of Advanced-Level Physics, University Tutorial College, Great Russell Street, London.

### **Present Employment:**

Writing three non-fiction books on: (a) Humankind's near-term future in space; (b) Climate change and its astronomical contributors; and (c) The case for deliberately infecting Mars with genetically-modified terrestrial organisms.

## **Latest Employment:**

Principal Research Scientist, QinetiQ Proprietary Limited (Canberra)

QPL is the Australian subsidiary of the UK-registered QinetiQ plc; this company was formerly (until 2008) called Ball Aerospace Australia, a subsidiary of the major US space systems contractor.

I am the holder of Australian Defence Security Authority SECRET clearance.

Duties and activities have included:

- Provision of scientific and technological guidance across a wide variety of Defence-related projects, in particular in the aerospace field
- Systems Engineering, in particular for complex communications networks
- Project Management
- Systems Architecture definitions for large and complicated (mostly Defence) projects
- Utilisation of a variety of architecture frameworks (DAF, DoDAF, TOGAF etc)
- Network Centric Warfare/Operations analysis, including the deployment of the various cross-national standard tools developed by the US-based NCOIC (Network Centric Operations Industry Consortium)
- Modelling and simulation using state-of-the-art software tools (including STK/Satellite Tool Kit, OPNET, MatLab and Simulink, and ExtendSim) used in capability development, battlespace analysis and dynamical architecture studies
- Consultant on several forward-looking Defence studies, such as:
  - Ballistic Missile Defence
  - Space Situational Awareness
  - Satellite Communications Roadmap
  - Future Joint Operations Concept (Space)
  - Advanced Mobile Operations Centre
  - Training and qualification of fast-jet (F/A-18) pilots
  - Future surveillance and reconnaissance upgrades for the Airborne Early Warning and Control system-of-systems (Australia's AWACS)
  - Land Battlefield Communications System (including SATCOM)
  - Network-Centric Warfare/Operations transformation.

## **Professional Memberships:**

Fellow of the Royal Astronomical Society

Member of the International Astronomical Union

Member of COSPAR (the international *COM*m*IT*tee on *SP*ace *RE*search)

Member of the Spaceguard Foundation

Member of the Planetary Society

Honorary Life Member, Astronomical Society of South Australia

## **Areas of Research Accomplishment:**

I have published over 140 papers in the refereed scientific literature (please see my appended *Publication List*), covering the following broad areas of research:

- Involvement in a number of spacecraft missions, in terms of instrument design; testing; data analysis; mission design; targeting; and other aspects; please see pp.6-7 below;
- Optical astrometry and physical observations of near-Earth asteroids, comets, and distant solar system objects, using a variety of telescope systems;
- Radar observations of meteors using VHF/HF/MF radars aimed at determining their heights of ablation, entry speeds and decelerations thence densities, compositions and origins;
- The design and operation of optical and radar systems for space situational awareness;
- Theoretical studies of the collisional evolution of the anthropomorphic space debris complex in geocentric orbit, including impact hazards specific to particular satellite orbits (for commercial applications of this work, please see pp.7-8 below);
- Modelling of the atmospheric ablation profiles of both natural meteoroids and artificial space debris;
- Investigations of the rates and consequences of impacts by asteroids and comets upon the planets using statistical computational techniques;
- Modelling of the stability of organic chemicals within meteoroids, asteroids and comets, and the supply of organics to the early Earth (and other planets) with relevance to the origin of life and astrobiology;
- Investigations of the effects of close planetary approaches on the orbits of small solar system bodies using statistical computation techniques, in particular with regard to the capture of parabolic comets and Kuiper belt objects into short-period orbits;
- Modelling of the chaotic orbital evolution of asteroids, comets and meteoroids through precise numerical parallel integrations aimed at understanding their origin and interrelationship;
- Research on calendrical mathematics: how the dynamics of the Earth, Sun and Moon affect calendar design;
- Fundamental contributions to the understanding of the Tunguska event in 1908, and the origin and nature of the causative projectile, through several distinct lines of enquiry (cf. my commentary 'Planetary science: Tunguska at 100', *Nature*, **453**, 1157-1159, 2008: <http://www.nature.com/news/2008/080625/full/4531157a.html>).

I have also published numerous articles and essays in the professional literature on subjects as diverse as the physics of the assassination of President Kennedy, the reality of the myth that an apple fell on Isaac Newton's head, the celestial inspiration for Samuel Taylor Coleridge's *Rhyme of the Ancient Mariner*, the pioneering work of Charles Babbage, how a partial solar eclipse led to the famous battle at Rorke's Drift, why global warming might be a good thing, the link between searches for extraterrestrial life and stonewashed jeans, why the planet Mercury has such a high metallic content, and the motivation for the building of the first developments at Stonehenge *circa* 3200 BCE.

## **Professional Positions of Responsibility:**

Managed several complex research projects, including fund raising, selection and hiring of staff, personnel management, budgeting, experiment planning, *etcetera*.

For the past decade I have been a member of the review team for the *Shoemaker NEO Grants of The Planetary Society*: <http://www.planetary.org/explore/projects/neo-grants/>

Member, UK delegation, OECD Global Science Forum Working Group on Near-Earth Objects: <http://www.oecd.org/dataoecd/39/40/2503992.pdf>

Advisor to the UK Near-Earth Object Task Force: [http://nearearthobjects.co.uk/neo\\_report.pdf](http://nearearthobjects.co.uk/neo_report.pdf)

Founder and Director, Anglo-Australian Near-Earth Asteroid Survey, 1990-96:  
[http://en.wikipedia.org/wiki/Anglo-Australian\\_Near-Earth\\_Asteroid\\_Survey](http://en.wikipedia.org/wiki/Anglo-Australian_Near-Earth_Asteroid_Survey)

Secretary, International Astronomical Union (IAU) Commission 22 (Meteors [, Meteorites] and Interplanetary Dust), 1988-94.

Secretary, IAU Commission 15 (Physical Studies of Comets, Minor Planets and Meteorites), 1991-94.

Trustee, International Institute for the Problem of the Asteroid Hazard (St Petersburg, Russia), 1995-97.

Member, IAU Working Group on Near-Earth Objects, 1991-present.

Member, IAU Working Group on the Prevention of Interplanetary Pollution, 1988-1997.

One of six foreign members of the *NASA International Workshop on the Detection of Near-Earth Objects* (a.k.a. the *Spaceguard Committee*), 1991-92:  
<http://impact.arc.nasa.gov/downloads/spacesurvey.pdf>

Only foreign member of the *NASA International Workshop on the Interception and Deflection of Near-Earth Objects* (*Los Alamos Publication LANL 12476-C*, 1993).

Invited reviewer or speaker at many international planetary and space research conferences; for example the *NASA Workshop on Scientific Requirements for Mitigation of Hazardous Comets and Asteroids* (2002):  
<http://www.noao.edu/meetings/mitigation/invited.html>

Contributed the section on *Meteors and Interplanetary Dust* for the fourth edition of *Allen's Astrophysical Quantities* (American Institute of Physics, 2000), the standard reference for professional astronomers.

Member of the Scientific Organising Committee of numerous international conferences.

Often asked to review manuscript submissions by international scientific journals such as *Nature*, *Planetary & Space Science*, *Astronomy & Geophysics*, *Icarus*, the *Journal of Astrobiology*, and the *Monthly Notices of the Royal Astronomical Society*.

Reviewer of book proposals for publishing houses such as Cambridge University Press and Yale University Press, and various commercial publishers.

## **Research Career Highlights:**

- Initiated, raised all funds for, and directed, the first-ever southern-hemisphere search for near-Earth objects (NEOs: asteroids and comets), delivering approximately 30 percent of all such discoveries made globally during the project's lifetime (1990-96), and a similar fraction of all NEO astrometry (*vide* paper number 122 in my *Publication List*, accompanying this CV).
- Identification of the first asteroid found to be spinning so quickly that it must be a monolith held together by cohesive forces rather than a rubble pile maintained by self-gravity, a long-term quest in the field (paper number 120).
- First-ever detection of interstellar dust entering Earth's atmosphere (paper number 106).
- Measurements of radar meteor heights at HF from Adelaide essential in understanding the influx detected by the Jindalee over-the-horizon radar, bringing the radar-detected flux into line with the population determined using space-exposure experiments such as NASA's *Long-Duration Exposure Facility* satellite (paper number 47, etc).
- Radar meteor observatory in New Zealand I helped design and build for my PhD work has delivered the heliocentric orbits of over a million sub-millimetre meteoroids, fifteen times the total number determined in all previous projects combined (paper 85).
- Identification of various weak meteor showers associated with specific Earth-crossing asteroids, indicating them to be extinct or dormant comets (paper number 26).
- Explained how comet 2P/Encke arrived in its unique cis-jovian orbit, this having been a problem since its discovery more than two centuries ago (paper number 112).
- Re-discovered from first physical principles the Yarkovsky-Radzievskii effect and its significance for small solar system bodies (paper number 15); this pseudo-force dominates the uncertainty over whether asteroid (29075) 1950 DA will strike the Earth in the year AD 2880: <http://neo.jpl.nasa.gov/1950da/>

### **Involvement with Spacecraft Projects:**

In 1988 (with an update in 1991) prepared a report for the IAU and COSPAR on the considerations relevant in choosing asteroid and comet targets for collision missions; this was of import in setting the context and selecting the target for NASA's *Deep Impact* mission in 2005.

Consulted frequently by NASA operations engineers regarding the impact hazard posed to major orbiting assets like the *Hubble Space Telescope* by meteor showers such as the Leonids and Perseids, which show annual variations and occasional storms.

Member of Science Concept Team for the *Earthguard 1* satellite proposal to ESA in 2002, in collaboration with Kayser-Threde GmbH.

Named by Brigadier-General Pete Worden (now Director of NASA-Ames Research Center) and the late Gene Shoemaker (the only person to have his ashes deposited on the Moon) to the Science Team for the *Clementine 2* mission planned by the US Defense Advanced Research Projects Agency (DARPA), to target three near-Earth asteroids; this was one of the 82 items vetoed in 1997 by the Clinton Administration (the use of intercept technologies developed under the *Brilliant Pebbles* part of the Strategic Defense Initiative was judged to be too aggressive, politically-speaking).

Collected vital astrometry for near-Earth asteroid (1620) Geographos in support of the US DoD's *Clementine* mission in 1994.

Collected astrometry for comet 26P/Grigg-Skjellerup in 1992, making feasible the close fly-by of the European Space Agency's *Giotto Extended Mission*.

Named to the Science Team for NASA's planned *Comet Rendezvous Asteroid Flyby* mission in 1988; this project was later cancelled.

Worked for ESA in 1987-88 on the *Bead Momentum Calibrator* in support of the analysis of data collected by the *Dust Impact Detection System* (DIDSY) aboard the *Giotto* space probe during the comet 1P/Halley encounter.

Preparation of a reference text for spacecraft engineers, 1980-82: *Space and Planetary Environment Criteria for use in Space Vehicle Development*, two volumes (edited by R.E. Smith & G.S. West), *NASA Technical Memoranda 82478* and *82501* (1983).

Observation planning and data analysis for the ultraviolet spectrometer on board NASA's *Pioneer Venus Orbiter*, 1980-81.

Instrument development for the *Solar Mesosphere Explorer* satellite, 1979-80.

### **Commercial Work on Space Debris:**

In 1988 I formed the company Spaceguard Proprietary Limited in South Australia, with the aim of commercialising software I had written that enabled me to calculate the risk of specified satellites being struck by space debris, or natural meteoroids. Within a year we underwent a friendly takeover by the Government Insurance Office (GIO) of New South Wales and the State Government Insurance Commission (SGIC) of South Australia. My partner and I then served as Directors of the new company, with myself in charge of all research and development.

The main success of the new Spaceguard Pty Ltd was in enhancing the GIO's share in the global satellite re-insurance market, with a doubling of its business in this area over the next three years. The SGIC also benefitted in various ways.

In the early 1990s two separate developments led to the winding up of Spaceguard Pty Ltd: one was the privatisation of the GIO, and the other the major losses incurred by the SGIC in connection with the collapse of the Bank of South Australia. These unconnected events resulted in the two insurance companies needing to divest themselves of the relatively small subsidiaries that they owned, and in consequence my partner and I reclaimed full control of the company, renamed Spaceguard Australia Pty Ltd. This traded successfully for another seven years (until I closed it on moving to the UK for four years in 1999), with the major income being derived from research contracts with the US Air Force Space Command and NASA pertaining to work on near-Earth objects, and also various activities on behalf of the Strategic Defense Initiative.

An aside: My membership of the *NASA Spaceguard Committee* has been mentioned above. That name has spawned a general trend to name relevant organisations similarly, such as the Spaceguard Foundation, Spaceguard UK, Spaceguard Croatia, the Japan Spaceguard Association, and so on. As can be seen from the above, at the time of my membership of that committee I also ran a company with that name, and that is not a coincidence: it was me who suggested the name for the proposed international NEO search program. In fact the term *Spaceguard* I derived originally from a fictitious asteroid search project described by Arthur C. Clarke in his novel *Rendezvous with Rama* (1972); note that Clarke provided the Foreword for one of my books, the Afterword for another, and the reader should also see the final sentence of this CV (page 14).



## **Ongoing Career in Writing and Broadcasting:**

### ***Contributor to The Guardian***

When the Columbia space shuttle disaster occurred in February 2003 I was asked to provide the leading Opinion-Editorial (OpEd) piece for *The Guardian* (London):

#### **To seek, to find and not to yield**

The Columbia disaster should not stop manned space trips

<http://www.guardian.co.uk/science/2003/feb/03/spaceexploration.comment>

### ***Other OpEds for The Guardian***

*Strife on Mars* (with Professor Sir Martin Sweeting):

<http://www.guardian.co.uk/comment/story/0,,972416,00.html>

*Why shouldn't aliens look like us?*

<http://www.guardian.co.uk/comment/story/0,,1278934,00.html>

*Easter is the thief of time*

<http://www.guardian.co.uk/science/2005/mar/26/sciencenews.comment>

*Looking for slime on Mars*

<http://education.guardian.co.uk/higher/research/story/0,9865,1112581,00.html>

*Global warming is good for you*

<http://www.guardian.co.uk/climatechange/story/0,,854111,00.html>

*Rock shock*

<http://www.guardian.co.uk/science/2000/sep/16/spaceexploration.comment>

### ***Guardian Feature Articles*** (some examples; dozens more available)

<http://education.guardian.co.uk/higher/research/story/0,,889467,00.html>

<http://education.guardian.co.uk/higher/research/story/0,,798941,00.html>

<http://education.guardian.co.uk/higher/engineering/story/0,,753671,00.html>

<http://education.guardian.co.uk/higher/physicalscience/story/0,,744436,00.html>

<http://www.guardian.co.uk/life/science/story/0,,923395,00.html>

<http://education.guardian.co.uk/higher/physicalscience/story/0,,524142,00.html>

<http://education.guardian.co.uk/higher/humanities/story/0,,510393,00.html>

<http://education.guardian.co.uk/higher/physicalscience/story/0,,482443,00.html>

<http://www.guardian.co.uk/life/science/story/0,,923138,00.html>

<http://www.guardian.co.uk/life/science/story/0,,923128,00.html>

<http://technology.guardian.co.uk/online/story/0,,212030,00.html>

<http://www.guardian.co.uk/life/science/story/0,,923081,00.html>

### ***Manchester Evening News***

Whilst working at the University of Salford, for three years I wrote a weekly column in the *Manchester Evening News* entitled *Ask A Rocket Scientist*; the acronym is notable. This appeared on a Saturday, when free issues of the *MEN* were given out at home games of Manchester United, Manchester City, and other major football clubs.

## **Other Newspapers and Magazines**

Contributor of articles to *New Statesman*, *New Scientist*, *The Australian*, *Prospect*, *The Independent*, *The Scotsman*, and many others.

I have written many space-related features for the UK magazines *BBC The Sky at Night*:

<http://www.skyatnightmagazine.com/>

...and *Astronomy Now*:

<http://www.astronomynow.com/>

Between 2003 and 2007 I was a Contributing Editor for *Sky & Space* magazine (Sydney), and during the 1990s for its predecessor, *Southern Astronomy*.

In January 2009 an article on which I had collaborated with Scottish SF author Ken MacLeod appeared as the cover story in the BBC's *Focus* science magazine:

<http://sciencefocus.com/issue/space-odyssey>

This article (*Space Odyssey*) concerned a futuristic tourist trip around many of the great sights and sites in the solar system, and the concept was used as the basis for a BBC TV documentary series.

I am often requested to provide jacket blurbs for popular science books; for example, for *The Science of Doctor Who* by Paul Parsons:

<http://www.iconbooks.co.uk/book.cfm?isbn=1-84046-737-1>

...and *25 Big Ideas—The Science That's Changing Our World* by Robert Matthews:

[http://www.oneworld-publications.com/cgi-bin/cart/commerce.cgi?pid=1&log\\_pid=yes](http://www.oneworld-publications.com/cgi-bin/cart/commerce.cgi?pid=1&log_pid=yes)

Invited contribution to John Brockman's book *The Greatest Inventions of the Past 2000 Years*, featuring ideas from "Today's Leading Thinkers" and introductory comments from Bill Gates:

<http://www.edge.org/documents/Invention.html>

[http://www.edge.org/3rd\\_culture/bios/steel.html](http://www.edge.org/3rd_culture/bios/steel.html)

<http://www.powells.com/cgi-bin/biblio?isbn=068485998x>

There follows a probably-incomplete listing of publications for which I have written articles over the past twenty years:

*The Planetary Report*, *Sky & Telescope*, *The Australian* and *New Zealand Physicist*, *Adrenalin* (a surfing and skateboarding magazine), *Southern Astronomy*, *Focus*, *New Statesman*, *New Scientist*, *The Australian*, *Prospect*, *The Independent*, *The Scotsman*, *Australasian Science Mag*, *Meteorite!* magazine, *BBC Sky at Night*, *Geophysics Down Under*, *Spaceflight* (the magazine of the British Interplanetary Society), *Astronomy Now*, *The Helix* (CSIRO), *Space Industry News*, *Werkgroepnieuws* (magazine of the International Meteor Organization: <http://www.imo.net/>), *Sky & Space*, *The Canberra Times*, the [sic] *Skeptic*, *Carter Observatory Astronomical Handbook*, *Space Frontier News*, *Asia-Pacific Space Report*, *Search: The Journal of the Australian and New Zealand Association for the Advancement of Science*, *Orbital Debris Monitor*, *Astronomy 1996* and *Astronomy 2003* (Quasar Publishing, Strathfield, NSW).

## **Television**

Appeared in dozens of TV documentaries broadcast globally, many of them national and international award winners. These have been broadcast by the BBC, Australian Broadcasting Corporation (ABC), TV New Zealand, the Discovery Channel, the SciFi Channel, commercial free-to-air networks, and so on.

I was Science Adviser (and appeared in) the two-hour documentary *Three Minutes to Impact* (Discovery Channel), made by York Films of London. This program has been seen by an estimated 400 million people. We were awarded the Emmy for *Best Documentary Script* in 1998 for this project.

In Australia I have appeared on ABC TV's *Lateline* programme (three times), Channel 9's *60 Minutes* (twice), and essentially all the other network TV news and current affairs programmes, live and recorded.

In 2002 an episode of the BBC's *The Sky at Night* – globally, the longest-running TV science programme – was dedicated to me and my research on near-Earth objects.

Once I gave 16 live interviews for American breakfast-time TV shows spread over four hours via satellite from the Telescope Technologies Limited factory in Birkenhead, Merseyside.

## **Radio**

Conducted over 500 radio interviews for the ABC alone, plus hundreds for the BBC, Radio New Zealand and a host of commercial channels; just a few examples:

<http://www.bbc.co.uk/radio4/science/venusacrossthesun.shtml>

<http://www.radionz.co.nz/replayradio/catalogue/science>

<http://www.abc.net.au/radionational/programs/scienceshow/transit-of-venus/3418576>

## **A Few Other Points:**

I have been quoted by *Time*, the *Times*, and the *New York Times*; expert comments regularly sought by journalists from newspapers and magazines such as the *Boston Globe*, *Washington Post*, *Los Angeles Times*, *Financial Times* and the (London) *Sunday Telegraph*, amongst others.

In Australia, I was the subject of a complete *Quantum Interview* programme on ABC TV, and a feature in the Qantas Airways in-flight magazine (entitled *Cosmic Caretaker*), both involving collaboration with Robyn Williams.

Consulted by the media to render a prompt physical explanation for the collapse of the World Trade Center's twin towers on 2001/9/11; for example:

<http://www.guardian.co.uk/world/2001/sep/12/september11.usa29>

A Google search on “*Duncan Steel*” currently throws up about 44,000 web pages, of which over 80 percent refer to me; the total number of web pages referring to my research, writing or broadcasting (as, for example, *D.I. Steel*) is rather more than 100,000. A few of the peculiar ways in which I appear on the internet are mentioned in the concluding section of this CV (page 14).

### **Book Writing in Progress:**

I currently have five non-fiction books (and one novel) in preparation.

The first is called *Our Next Giant Leaps*. This will deal with humankind's next steps out into the cosmos: what is foreseeable for both manned and robotic space exploration, and also space *exploitation*.

The second book has the working title *Earth's Orbit and Contemporary Climate Change*; it will cover the various ways in which extraterrestrial factors affect the Earth's climate. Surprisingly enough, some simple effects (such as the precession of perihelion) have not been included in most climate modelling.

The third book is to be entitled *Inoculating Mars*; in it will I argue that humankind could and should deliberately infect Mars with genetically-modified micro-organisms designed and constructed to be able to thrive there, once we are sure that the planet has no indigenous life forms.

The next, with the working title *God's Meridian*, concerns the hitherto secret astronomical reason for the British colonisation of Virginia between 1584 and 1620. This factual – although yet to be proven – background has been used by my friend Bill Napier as the basis for his novel *Splintered Icon* (UK edition: *Shattered Icon*), which has sold over half a million copies.

The fifth book, called *Babbage's Big Blue*, will deal with the astronomically-connected intrigues and foul deeds that led to all British government funding for the development of Charles Babbage's mechanical calculating engines being cut off around 1840, resulting in a huge set-back in the eventual development of electronic computers a century later.

### **Public Speaking:**

Over 300 public talks given to a wide variety of audiences ranging from school children through amateur astronomical societies and university science clubs to Rotary clubs and the like. The latest: Bath Science Café on April 16. The next: in two days' time, at the opening of an art exhibition at the CSIRO *Discovery Centre* in Canberra, the artwork being inspired by detailed up-close views of nature.

Selected to give the public discourses at the *UK National Astronomy Meetings* in both 2001 (University of Cambridge) and 2003 (Trinity College, Dublin).

Prestigious public talks presented include:

- *Robinson Lecturer*, Armagh, 1996 (following the Astronomer Royal for Scotland and the Director of the Jodrell Bank Observatory).
- *Chalklin Lecturer*, Royal Society of New Zealand, 1994.
- Graduation speech, Charles Sturt University, 1994.

I have given public talks at locations as diverse as the Smithsonian Institution in Washington DC, the Guinness factory in Dublin, the United Nations in New York City, a high school in Tokyo, the Cheltenham Town Hall in England, and at the Audubon Society in New Orleans.

### **Teaching and Lecturing Experience:**

Extensive lecturing experience at universities in the UK, USA, New Zealand and Australia at all levels from beginning undergraduates (both physics majors and service courses to other science/engineering/pre-medicine students) to graduate seminars in my specialist area. Supervised numerous student research projects: final year (*i.e.* third year) undergraduates, Honours year, master's degree and PhD students. Previous to this I was a full-time high-school teacher in London.

Experience with 'Gifted and Talented' students in South Australia, New South Wales and England. For example, gave Saturday afternoon talks on basic physics, optics, and space science to G&T groups in Adelaide; ran an astronomy specialist study group in north-western NSW (students spread over several hundred kilometres); and brought selected high school pupils in from across Lancashire for university laboratory visits and talks in Manchester plus gave many G&T presentations in Southport.

### **Other Occupations:**

Over the years I have spent various periods in a wide range of jobs: ice-cream salesman, caravan dealer, cinema projectionist, bakery deliveries, bingo caller, disc jockey, child counsellor on a summer camp in New York state, worked on various farms, several volunteer organisations.

Whilst an undergraduate, I organised all social functions (concerts, discotheques, movies) for the student body at my college; for example, an all-night Christmas Ball for over a thousand people.

Often press-ganged into selling fruit and vegetables at the Canberra Farmers' Markets by the energetic Italian octogenarian who employed my sons to help him on Saturday and Sunday mornings.

With my sons I collect photographs of the characterful mailboxes one finds scattered around Australian and New Zealand country areas. These we format into a calendar, get them printed up, and sell them online.

## Quirky Things to Finish:

Minor planet (4713) *Steel* was named for me by the International Astronomical Union in recognition of my research work on small bodies in the solar system. I have myself found a dozen minor planets (synonym: asteroids) and suggested names for them, as is the privilege of the discoverer. Two of these are named for my sons: (5263) *Arrius* and (6828) *Elbsteel*. The Wikipedia pages for those two are often the subject of defacement and good-natured abuse by my sons' friends.

Other asteroids named by me, or with my collusion, include (2472) *Bradman* for Sir Donald, with his agreement and appreciation; (4456) *Mawson*, which might be of note to geologists; (6870) *Pauldavies*; and (7345) *Happer* for the character played by Burt Lancaster in the wonderful movie *Local Hero*: in the screenplay Felix Happer really wanted to have a comet named for himself.

I have visited more than sixty countries.

In the 2010 *Relay for Life* organised by Cancer Council Australia at the Australian Institute of Sport stadium I covered the marathon distance during the night, and raised almost \$3,000 for cancer research – the sixth highest individual total in the ACT. I also do much charitable work through Rotary International.

I introduced the *Sex Pistols* in one of their first concerts (November 1975); see also [http://en.wikipedia.org/wiki/Duncan\\_Steel](http://en.wikipedia.org/wiki/Duncan_Steel)

There is a website... [http://bayblab.blogspot.com.au/2007/10/6-badass-scientists\\_16.html](http://bayblab.blogspot.com.au/2007/10/6-badass-scientists_16.html) ... which states that “*When most people imagine a scientist, they see a skinny, pasty white nerd, with thick glasses, no sense of fashion and an absent-minded, self-effacing personality. But many scientists are just the opposite. This is a list of the 6 most badass scientists that clash with this stereotype.*” In that esteemed ranking I come in fourth, behind Craig Venter, Richard Feynman, and Andrei Sakharov.

In terms of the *Manliest Names in the World*, I do not do as well, being listed only in fifth place: [http://www.cracked.com/article\\_14982\\_9-manliest-names-in-world.html](http://www.cracked.com/article_14982_9-manliest-names-in-world.html) (...and with a photograph of a *different* Duncan Steel – who is by no means as ruggedly handsome as me – being erroneously posted there).

If you Google on ‘Duncan Steel star’ you will be taken to a web page on which I am voted, it seems, to have the best possible name for a male porn star (which I am not!)

And finally, a lunar-roving automaton in Arthur C. Clarke’s 1992 novel *The Hammer of God* is named for me: Robot Steel.

# Duncan Steel : Publication List

## Books

### **Eclipse: The Celestial Phenomenon That Changed the Course of History**

(Revised and expanded American edition published by the Joseph Henry Press, National Academy of Sciences, Washington DC, 2001; Foreword by Paul Davies).

### **Target Earth**

(Reader's Digest, New York, Sydney & elsewhere, 2000; Time-Life Books, London & elsewhere, 2001; with an Afterword by Arthur C. Clarke; also published in German, Dutch, and other languages).

### **Marking Time: The Epic Quest to Invent the Perfect Calendar**

(John Wiley & Sons, Inc., New York, Chichester, Weinheim, Brisbane, Singapore & Toronto, 2000; paperback, 2001).

### **Eclipse: The Celestial Phenomenon Which Has Changed the Course of History**

(Headline Books, London & elsewhere, 1999; revised paperback, 2000; with a Foreword by Paul Davies).

### **Rogue Asteroids and Doomsday Comets**

(John Wiley & Sons, Inc., New York, Chichester, Brisbane, Toronto & Singapore, 1995; paperback, 1997; with a Foreword by Arthur C. Clarke).

## Book Chapters (partial listing)

Duncan Steel, 'To the Furthest Ends of the Earth', pp.55-77 in *The Transit of Venus: How a Rare Astronomical Alignment Changed the World*, Awa Press, Wellington, NZ (2007): <http://www.awapress.com/products/published/books/sciencenature/alalignmentchangedtheworld>

Duncan Steel, 'Twice a Fortnight: the Astronomical Origin of the Week' pp.177-186 in *2007 Yearbook of Astronomy* (edited by Patrick Moore and John Mason), Macmillan, London (2006).

D. Morrison, C.R. Chapman, D. Steel & R.P. Binzel, 'Impacts and the Public: Communicating the Nature of the Impact Hazard', pp.353-390 in *Scientific Requirements for the Mitigation of Hazardous Comets and Asteroids* (edited by M.J.S. Belton, T.H. Morgan, N.H. Samarasinha & D.K. Yeomans), Cambridge University Press (2004): <http://www.cambridge.org/gb/knowledge/isbn/item5688168/>

Duncan Steel, 'Life in the cosmos... and under our feet', pp. 122-130 in *Frontiers 03: New Writing on Cutting-Edge Science by Leading Scientists* (edited by Tim Radford), Atlantic Books, London (2003).

Duncan Steel, chapter on *Planetary Satellites, Asteroids, Comets and Meteors*, in the *UNESCO Encyclopedia of Life Supporting Systems* (2003): <http://www.eolss.net/>

Duncan Steel, 'Ices in the Solar System', pp.252-254 in *The Solar System* by Nigel Hey, Weidenfeld & Nicolson, London (2002).

Duncan Steel, 'Near-Earth Objects: Getting Up Close and Personal' pp.154-180 in *2003 Yearbook of Astronomy* (edited by Patrick Moore and John Mason), Macmillan, London (2002).

Duncan Steel, all entries (over 120) on *Minor Planets/Asteroids* and also *Small Moons of the Planets* in *Philip's Astronomy Encyclopedia*, London (2002).

- Duncan Steel, 'Eros on St Valentine's Day', pp. 91-95 in *Frontiers 01: Science and Technology 2001-02* (edited by Tim Radford), Atlantic Books, London (2002).
- R.P. Binzel, M.S. Hanner & D.I. Steel, 'Solar System Small Bodies', Chapter 13 in *Allen's Astrophysical Quantities, 4th Edition* (edited by A.N. Cox), Springer/American Institute of Physics, New York (2000).
- D. Steel, 'Cometary impacts on the biosphere', pp.209-242 in *Comets and the Origin and Evolution of Life* (edited by P.J. Thomas, C.F. Chyba & C.P. McKay), Springer-Verlag, New York (1997).
- Duncan Steel, *Foreword* (pp.9-13) to *Handbook for Visual Meteor Observers* (edited by J. Rendtel, R. Arlt and A. McBeath), International Meteor Organization, Potsdam, Germany (1995).
- Duncan Steel, 'Meteoroids from interstellar space?' pp.184-195 in *1996 Yearbook of Astronomy* (edited by Patrick Moore), Macmillan, London (1995).

## **Defence-Related Papers and Reports**

Over the past eight years, whilst working in the Defence Industry sector in Canberra, I have been sole, lead or contributing author on many formal scientific and technical reports and other documents that are CLASSIFIED (*Restricted, Confidential, or Secret*) by the Defence Security Authority, and therefore cannot be listed or described herein. One exception is this paper:

Jeremy Wells, Craig Williams, Braden McGrath & Duncan Steel,  
 'Modelling of Future Mobile Communications Network Concepts',  
*Military Communications and Information Systems*, Canberra (2008):  
<http://www.milcis.com.au/milcis2008pdf/Reviewed%20papers/Wells-final.pdf>

Whilst I deliberately listed myself last amongst the authors, in fact I wrote and presented that publication, which won the award for *Best Paper* at the *MilCIS 2008* conference.

## **Publications Not Listed**

A substantial number (some hundreds) of separate publications pertaining to the telescopic discovery, recovery or astrometric follow-up of minor planets (*i.e.* asteroids) and comets published in the *International Astronomical Union Circulars* and the *Minor Planet Circulars* in 1990–96, and the *Minor Planet Electronic Circulars* in 1993–1996, have not been included here.

Reference to the *NASA Astrophysics Data System* (<http://adswww.harvard.edu/>) indicates that during the 1990s, through the majority of which I was a full-time researcher, over 200 publications bearing my name appeared across the broad astronomy and astrophysics field (including planetary science); I also published papers and commentaries during that period in journals pertaining to other fields (*e.g.* atmospheric physics and chemistry; space science; astronautics and space technology; orbital space debris; and mainstream physics).

Similarly many articles (over 500) written for popular-level magazines, newspapers and the like have not been listed herein, and book reviews written by myself, whether published in refereed journals or not, have also been excluded. A partial list of those publications for which I have written (*e.g.* *The Guardian*, *The Australian*, *New Statesman*, *Prospect*, *New Scientist*, *BBC Sky at Night*, *Adrenalin*, and *Focus*) is given in the main body of my CV.



## Refereed Papers in Journals and Conference Proceedings

143. Duncan Steel, 'Implications of the Centaurs, Neptune-Crossers and Edgeworth-Kuiper Belt for Terrestrial Catastrophism', *International Conference on Volcanism, Impacts and Mass Extinctions*, London, March 2013; *Geological Society of America Special Papers*, in press (2014).
142. Duncan Steel, 'Perihelion precession, polar ice and global warming,' *Journal of Cosmology*, 22, 10106-10129 (2013).
141. Duncan Steel & Harrison Steel, 'A Large Optical Arecibo for NEO Discovery', *Third International Astronautical Academy Planetary Defense Conference* (Flagstaff, Arizona), April 2013.
140. Duncan Steel & Harrison Steel, 'An r-strategy Architecture for the Robotic Exploration of Mars', presented at the *Australian Mars Exploration Conference XII, Canberra* (September 2012).
139. D.J. Asher & D.I. Steel, 'Draconid meteor storms', *Proceedings of the International Meteor Conference 2011*, Sibiu, Romania: edited by M. Gyssens & P. Roggemans, International Meteor Organization, pp.40-43 (2012).
138. Duncan Steel & Harrison Steel, 'Space Reconnaissance: Scanning the Sky with an Optical Arecibo', *Proceedings of the 11th Australian Space Science Conference*, pp.1-11, edited by Wayne Short & Iver Cairns, National Space Society of Australia (2012); ISBN 13: 978-0-9775740-5-6; 14MB download from: <http://www.nssa.com.au/11assc/downloads/11ASSC-Proceedings-web.pdf>
137. Duncan Steel, 'A hypothesis for Mercury's high metal content', *Proceedings of the 11th Australian Space Science Conference*, pp.87-92, edited by Wayne Short & Iver Cairns, National Space Society of Australia (2012); ISBN 13: 978-0-9775740-5-6; <http://www.nssa.com.au/11assc/downloads/11ASSC-Proceedings-web.pdf>
136. Harrison Steel & Duncan Steel, 'The Range of Asteroid/Meteoroid and Comet Impact Velocities and Probabilities onto Mars as a Function of Heliocentric Distance', *Australian Mars Exploration Conference XI*, University of Western Australia, Perth (July 2011).
135. Duncan Steel, 'Planetary science: Tunguska at 100', *Nature*, **453**, 1157-1159 (2008): <http://www.nature.com/news/2008/080625/full/4531157a.html>
134. D. Steel, 'Electromagnetic perturbations of the orbits of asteroids', pp.433-436 in *European Space Agency Special Publication SP-500: Asteroids, Comets, Meteors* (2002).
133. D. Steel, 'Terrestrial impact rates for the known population of Earth-crossing asteroids', pp.145-147 in *European Space Agency Special Publication SP-500: Asteroids, Comets, Meteors* (2002).
132. D. Steel, 'The proper length of a calendar year', *Astronomy & Geophysics*, **43**, 9 (2002).
131. D. Steel, 'Searching for NEOs Using Wide-Field Telescopes', pp. 253-262 in *The New Era of Wide-Field Astronomy* (edited by R. Clowes, A. Adamson & G. Bromage), *Astronomical Society of the Pacific Conference Series*, **232** (2001).
130. D.J. Asher, M.E. Bailey & D.I. Steel, 'The role of non-gravitational forces in decoupling orbits from Jupiter', pp. 121-130 in *Collisional Processes in the Solar*

*System* (edited by M.Ya. Marov & H. Rickman), *Astrophysics and Space Science Library*, **261**, Kluwer Publishing, Dordrecht, The Netherlands (2001).

129. D. Steel, 'The Leonid meteors: compositions and consequences', *Astronomy & Geophysics*, **39**, 24-26 (1998).
128. D.I. Steel, 'Before the Stones: Stonehenge I as a Cometary Catastrophe Predictor', pp.33-48 in *Natural Catastrophes During Bronze Age Civilisations: Archaeological, Geological, Astronomical and Cultural Perspectives*, (edited by B.J. Peiser, T. Palmer & M.E. Bailey), *British Archaeological Reports International Series*, **728** (1998).
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119. D.I. Steel, 'Meteoroid orbits: Implications for near-Earth object search programs', *Annals of the New York Academy of Sciences*, **822**, 31-51 (1997).
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117. D. Steel, 'Asteroid and comet impact speeds upon Mars: Significance for panspermia and the supply of organics', pp.197-201 in *IAU Colloquium 161: Astronomical and Biochemical Origins and the Search for Life in the Universe* (edited by C.B. Cosmovici, S. Bowyer & D. Werthimer), Editrice Compositori, Bologna, Italy (1997).
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114. D. Steel, 'Meteoroid orbits', *Space Science Reviews*, **78**, 507-553 (1996).
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111. D.J. Asher & D.I. Steel, 'The orbital evolution of P/Machholz 2 and its debris', *Monthly Notices of the Royal Astronomical Society*, **280**, 1201-1209 (1996).
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109. D.J. Asher & D.I. Steel, 'No meteor storms expected from P/Machholz 2', *IAU Colloquium 150: Physics, Chemistry and Dynamics of Interplanetary Dust* (edited by B.Å.S. Gustafson & M.S. Hanner), *Astronomical Society of the Pacific Conference Series*, **104**, 129-132 (1996).
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103. D. Steel, 'The death of the dinosaurs and protection of humankind from asteroid impacts: the first suggestion?' *Australian Journal of Astronomy*, **6**, 87-90 (1995).
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100. D. Steel, 'Tunguska and the Kagarlyk meteorite', *The Observatory*, **115**, 136-137 (1995).
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98. D.J. Asher & D.I. Steel, 'Theoretical meteor radiants for macroscopic Taurid Complex objects', *Earth, Moon & Planets*, **68**, 155-164 (1995).
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74. D.J. Asher, S.V.M. Clube & D.I. Steel, 'Asteroids in the Taurid Complex', *Monthly Notices of the Royal Astronomical Society*, **264**, 93-105 (1993).
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