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Advanced Fellowship PROPOSAL

Document Status: With Owner
PPARC Reference:

PPARC Fellowships 2006

Organisation where the Fellowship would be held (mandatory)

Organisation	University College London	Research Organisation Reference:	32279
Division or Department	Space and Climate Phys Mullard Space		

Title of Proposed Research (mandatory) [up to 150 chars]

Energy flows in stellar coronae

Start Date and Duration (mandatory)

a. Proposed start date	01 October 2007	b. Duration of the grant (months)	60

Applicants (mandatory)

Role	Name	Organisation	Division or Department
Fellow	Dr Giulio Del Zanna	University College London	Space and Climate Phys Mullard Space

Years of Post-Doctoral Experience

The number of years of postdoctoral experience at the time of taking up a fellowship award.	7

Choice of Host Institution (mandatory)

Please explain the choice of your host organisation [up to 4000 characters]

The solar-stellar astrophysics group is the ideal place to carry out this project, given its long-standing involvement in solar and stellar space missions. In particular, the group has been actively involved in the SOHO mission and the CDS spectrometer, and has built the EIS spectrometer onboard Hinode (SolarB), launched in September 2006 (P.I.: Prof. Len Culhane). These are the only EUV spectrometers that will study the solar corona for many years to come, probably until the new ESA mission, Solar Orbiter, currently planned for 2017.

Given my extensive experience on EUV spectroscopy, I could contribute significantly to the scientific output of Hinode with my research programme, which fits well with the overall science aims of the solar group at MSSL. A fellowship at MSSL would give me the possibility to lead various projects for which I have already set up the relevant collaborations, and strengthen solar science in the UK. It will also allow me to continue to be actively involved in the planning of new missions (e.g. Solar Orbiter).

MSSL also hosts various e-grid activities (e.g. astrogrid, e-SDO) regarded as priorities within the community, and to which I could provide significant contributions. My proposal to make atomic data accessible within astrogrid was recently accepted, and a fruitful collaboration has just started.

MSSL is also part of the consortium that built XMM-Newton, and there is expertise on observations and analysis of X-ray spectra.

For the studies of possible effects of the solar EUV irradiance, a collaboration with the climate physics group at MSSL will be established.

Objectives (mandatory)

List the main objectives of the proposed research in order of priority [up to 4000 chars]

1) Determine the characteristics of the EUV spectral irradiance, its variations during the last solar cycle and its relation with magnetic activity on the Sun. Also, find ways to predict the EUV irradiance with modelling.

2) Investigate which processes dominate the energy release and transport in the solar corona, in particular in loops and flares. Study non-equilibrium and non-thermal effects in the solar corona.

3) Determine the physical characteristics of the whole solar corona during the last cycle
and relate them to those of other stars. Identify in which other stars the observed X-ray emission could be due to a solar-like corona. Determine chemical abundances in stellar coronae (including the Sun).

4) Identify the fundamental plasma processes that determine the formation of EUV spectral lines in stellar coronae.

5) Calculate and benchmark the atomic data needed to interpret the observations of stellar coronae.

Summary (mandatory)

Describe the proposed research in simple terms in a way that could be publicised to a general audience [up to 4000 chars]

The Sun is the only star that we can study in detail, from its interior to the outer atmosphere (corona) and the solar wind, which permeates the entire solar system. The solar corona is also an unique laboratory that we can use to understand fundamental plasma processes that occurr throughout the universe (most of which is composed of magnetised plasma). The solar irradiance and particle flux fundamentally affect space weather, our atmosphere and the global climate of our planet.
Yet, we have so far failed to understand many fundamental questions about the Sun (and stars in general). The standard model of the Sun has recently been called into question. We still do not know the prime mechanisms that heat the solar corona to millions of degrees, that cause flares and eruptions, that accelerate particles, that produce the strongest emission in the Extreme Ultra Violet (EUV). We also know very little about the solar irradiance in the EUV or X-rays, and its potential effects on the global climate of our planet. As for other stars, we know that most have strong X-ray emission, however the processes that produce these X-rays are still largely unknown.

This is a golden age for the physics of the solar corona, with a wealth of data gathered by recent (SOHO, TRACE, RHESSI) missions, now complemented with Hinode (Solar-B), and soon with STEREO, SDO. The two EUV spectrometers (SOHO/CDS, Hinode/EIS) have a strong UK involvement. I believe that it is timely to invest more resources into the analysis and interpretation of these spectroscopic data, because they hold the key to advance our understanding of the solar corona. The current sensitivity and resolution of EIS will allow novel studies. In particular, I intend to couple observations with theoretical modeling to understand which processes dominate the energy release and flow in the corona, by taking into account non-equilibrium and non-thermal effects in the plasma. In particular, I will study

the location and evolution of heating in coronal loops in relation with the changes of the magnetic field, and energy flows during flares, in relation to chromospheric evaporation.

Spectral observations and realistic atmospheric models will also shed light on the problem of why the brightest EUV lines are so bright, so in the future we will also be able to predict their emission.

I also plan to use the unique 10-year long SOHO observations to characterise for the first time the EUV spectral irradiance and its variations with the solar cycle. We will then be able to study any possible effects on global climate.

With the same observations I will also obtain the physical characteristics of the solar corona during the last cycle. With these and some modeling, it will be possible to simulate in detail the X-ray emission from other stars. With these simulations, and Chandra and XMM-Newton observations of stars of different ages, it will be possible to understand in which cases the observed X-ray emission could be due to the presence of a hot corona similar to an active Sun.

Provision of accurate atomic data forms an integral part of this proposal, given their importance for plasma diagnostic and modeling. I plan to continue the work on the ions for the EUV and X-rays, and to provide atomic data to allow studies of non-equilibrium and non-thermal effects, which are presumably important in the solar corona.

Summary of Resources Required for Project

Financial resources

Summary fund heading	Fund heading	Full economic Cost	PPARC contribution	% PPARC contribution
Directly Incurred	Staff	251125.14	200900.11	80
	Travel & Subsistence	10000.00	8000.00	80
	Equipment	5000.00	4000.00	80
	Other Costs	0.00	0.00	80
	Sub-total	**266125.14**	**212900.11**	
Directly Allocated	Investigators	0.00	0.00	80
	Estates Costs	52545.00	42036.00	80
	Other Directly Allocated	0.00	0.00	80
	Sub-total	**52545.00**	**42036.00**	
Indirect Costs	Indirect Costs	219140.00	175312.00	80
Exceptions	Equipment	0.00	0.00	100
	Sub-total	**0.00**	**0.00**	
	Total	**537810.14**	**430248.11**	

Summary of staff effort requested

	Months
Investigator	60
Researcher	0
Technician	0
Other	0
Visiting Researcher	0
Student	0
Total	60

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Other Support

Details of support sought or received from any other source for this or other research in the same field.

Awarding Organisation	Awarding Organisation's Reference	Title of project	Decision Made (Y/N)	Award Made (Y/N)	Start Date	End Date	Amount Sought/Awarded (£)

Staff

Directly Incurred Posts

							EFFORT ON PROJECT					
Role	**Name /Post Identifier**	**JNCHES**	**Basic Starting Salary / Starting Spine Point**	**Grade / Scale**	**Increment Date**	**Start Date**	**Period on Project (months)**	**% of Full Time**	**London Allowance (£)**	**Super-annuation and NI (£)**	**Total Other Allowances (over period of appointment) (£)**	**Total cost on grant (£)**
Fellow	Dr Giulio Del Zanna	N	37562.83	Grade 8	01/10/2007	01/10/2007	60	100	0	8400.70	0	251125.14
											Total	251125.14

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Equipment (the cumulative value of equipment over £50,000 will be treated as an exception)

Description	Country of Manufacture	Delivery Date	Basic price £	Import duty £	VAT £	Total £
Equipment in support of the project, ie a laptop	United Kingdom	05/10/2007	4,255.00		745	5000
					Total £	5000

Other Directly Allocated Costs

Description	Total £
Total £	0

Other Directly Incurred Costs

Description	Total £
Total £	0

Classification of Proposal

(a) Scientific Areas (mandatory)

Assign % relevance (in multiples of 5) to any areas that are relevant, totalling 100%

Scientific Area	Broad Indication of Category	%
Astronomy, celestial mechanics, databases and survey astronomy	eg. Catalogues, star atlases, stellar dynamics	10
Beyond the Standard Model	eg. Origin of mass	
Extra-galactic astronomy and cosmology	eg. Galaxy formation and evolution, active galactic nuclei, jets, quasars, large scale structure, clustering, early Universe, Hubble constant, cosmic microwave background, inflation	
Galactic and inter-stellar astronomy	eg. Galactic centre, star clusters, Galactic structure, formation and evolution of the Galaxy, kinematics and dynamics of the Galaxy, inter-stellar medium, molecular clouds, planetary nebulae, supernovae remnants, dust inter-stellar chemistry	
Particle cosmology	eg. Dark matter, supersymmetry, neutrinos, cosmic strings	
Physics and physical processes not specifically astronomy, planetary science or particle physics	eg. Accretion, black hole physics, gravity, magnetic fields, atomic and molecular processes, relativity	30
Planetary science	planets and other Solar System bodies (other than the Sun) and extra-Solar System planetary systems	
Solar and solar-terrestrial physics	the Sun, ionospheric physics, magnetosphere, solar wind, solar terrestrial relations	50
Stars	including pulsars, supernovae, nucleosynthesis, protostars and young stellar objects, star formation, brown dwarfs	10
The Standard Model	eg. Quarks, leptons, cp-violation, matter-antimatter asymmetry, QCD, electroweak interactions, supersymmetry (SUSY)	
		Total = 100%

(b) Types of Activity (mandatory)

Assign % relevance(in multiples of 5) to the activities listed, totalling 100%

Type of Activity	Broad Indication of Category	%
Exploitation and experiment	Data collection, data analysis, experimental research	60
Investment in new instrumentation, facilities or techniques	For example, design and construction of new facilities and instruments, instruments and technique development and research on underpinning technology	5
Operation and maintenance of facilities	The recurrent cost of providing facilities	
Theory	Theoretical research including modelling	35
		Total = 100%

(c) Facilities or Wavelengths

If the programme is associated with a particular wavelength range, assign % relevance (in multiples of 5) to each relevant wavelength. For particle physics, please indicate the facility. The allocations need not sum to 100%.

Facility/Wavelength	%
Gamma-ray	
HERA	
LEP	
LHC	
mm/sub-mm	
Optical/IR	10
Other particle physics facilities	
Radio	
UV	40
X-ray	50
	Total <= 100%

(d) Space or Ground Based

If applicable, please assign relevance (in multiples of 5) to ground or space-based activities.

Ground or Space	%
Ground-based	10
Space-based	90
	Total <= 100%

OTHER INFORMATION

Reviewers

1	Name	Organisation	Division or Department	Email Address
Dr Helen Mason		University of Cambridge	Applied Maths and Theoretical Physics	h.e.mason@damtp.cam.ac.uk

Reviewers

2	Name	Organisation	Division or Department	Email Address
Professor JL Culhane		University College London	Space and Climate Phys Mullard Space	jlc@mssl.ucl.ac.uk