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Ernest Rutherford Fellowships PROPOSAL

Document Status: With Owner
STFC Reference:

Ernest Rutherford Fellowships 2022

Organisation where the Fellowship would be held

Organisation	University of Exeter	Research Organisation Reference:	BID123159
Division or Department	Physics and Astronomy		

Title of Proposed Research [up to 150 chars]

Improved magnetoconvection models for precision astrophysics

Start Date and Duration

a. Proposed start date	01 June 2023	b. Duration of the grant (months)	60

Applicants

Role	Name	Organisation	Division or Department
Fellow	Dr Evan Anders	Private Address	Private Address

Years of Post-Doctoral Experience

Years of postdoctoral experience at 1 September next year	3

If you are returning to research from a career break please tick

Proposal Classifications

Classification Areas:

Research Areas are the subject areas in which the research proposal may fall and you should select at least one of these with a maximum of five allowed. You will need to assign the relative percentage totaling 100% across all areas selected. To add or remove Research Areas use the relevant link below. To set a primary area, click in the corresponding checkbox and then the Set Primary Area button that will appear.

Subject	Topic	Indicator %	Keyword
Astronomy - theory	Computational Methods and Tools	30	
Astronomy - theory	Stellar Astronomy	70	

Qualifiers:

Qualifiers are terms that further describe the area of your research and cover aspects such as approach, time period, and geographical focus. Please ensure you complete this section if relevant. To add or remove Qualifiers use the links below.

Keywords:

Free-text keywords may be used to describe the subject area of the proposal in more detail. To add or remove those previously added use the links below.

Objectives

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

Modern precision observations have revealed major theoretical shortcomings in models of convection and demand a new state-of-the-art set of convective simulations. The goal of this proposal is to build a next-generation set of global and local 3D numerical simulations, which will answer the following three questions (ranked here by priority):

(1) How large are convective cores in massive stars?

(2) How does surface convective blueshift vary across stellar mass?

(3) How does magnetoconvection affect the radii of low-mass, fully convective stars?

Summary

Describe the proposed research in simple terms in a way that could be publicised to a general audience [up to 4000 chars]. Note that this summary will be automatically published on STFC's website in the event that a grant is awarded.

Current and next-generation space- and ground-based observatories are revolutionizing precision observations in astrophysics.

Long observations ("lightcurves") from space missions like Kepler, TESS, and (soon) ESA's PLATO have enabled the detection of thousands of planets. Follow-up observations in the search for extrasolar planets measure how much a planet's gravity moves its host star. Since planets are small compared to stars, these signals are faint, and variation from convective turbulence (like storms on Earth) at the surface of the star can drown out any chance of detecting planet-induced motion. The proposed research will improve models of convection at the surface of stars to enable the detection and classification of extrasolar planets.

The lightcurve observations that let us discover planets also let us see waves that provide information about the insides of stars through the field of asteroseismology, just like we use waves to learn about the inside of earth via seismology. These waves provide information about mixing and convection that occurs deep within stars which we cannot observe in any other way. Our current models of convective mixing are at odds with these observations and must be improved. Deep mixing can inject fresh fuel into the core of stars, lengthening the lifetime of the star and determining whether the star will eventually turn into a small white dwarf, a neutron star, or a black hole. The proposed research will improve models for determining which stars will end their lives as black holes.

In summary, our models of convective motions and convective mixing in stars are imprecise. These uncertainties make it difficult to detect small exoplanets, and also make it difficult to understand our observations of the most massive objects in the galaxy (black holes and neutron stars). This research proposal will improve models of convection by creating the first 3D, full-sphere magnetic simulations of massive stars and small stars (M dwarfs). These convective models will be used to improve estimates of how stars age, which will in turn affect predictions of what stars evolve into (e.g., black holes vs. neutron stars). We also propose to create a suite of smaller, "star-in-a-box" simulations which capture convective motions at the surface of stars to help enable the detection of earth-like planets around Sun-like stars.

Summary of Resources Required for Project

Financial resources

Summary fund heading	Fund heading	Full economic Cost	STFC contribution	% STFC contribution
Directly Incurred	Staff	368458.00	294766.40	80
	Travel & Subsistence	10000.00	8000.00	80
	Other Costs	8000.00	6400.00	80
	Sub-total	**386458.00**	**309166.40**	
Directly Allocated	Investigators	0.00	0.00	80
	Estates Costs	44895.00	35916.00	80
	Other Directly Allocated	3470.00	2776.00	80
	Sub-total	**48365.00**	**38692.00**	
Indirect Costs	Indirect Costs	249465.00	199572.00	80
	Total	**684288.00**	**547430.40**	

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.
Other support is not relevant to this application.

Staff

Directly Incurred Posts

			EFFORT ON PROJECT							
Role	**Name /Post Identifier**	**Start Date**	**Period on Project (months)**	**% of Full Time**	**Scale**	**Increment Date**	**Basic Starting Salary**	**London Allowance (£)**	**Super-annuation and NI (£)**	**Total cost on grant (£)**
Fellow	Dr Evan Anders	01/06/2023	60	100	G42	01/08/2023	50300	0	17316	368458
									Total	368458

Other Directly Allocated Costs

Description	Total £
Infrastructure Technicians	3470
Total £	3470

Other Directly Incurred Costs

Description	Total £
Consumables	5000
Relocation costs	3000
Total £	8000

Classification of Proposal

(a) Peer Review Preferences

Tick one of the following boxes to indicate the STFC fellowships peer review panel you consider most appropriate to review this fellowship.

Accelerator Physics	
Astronomy Extragalactic	
Astronomy Near Universe	x
Particle Physics Experiment	
Particle Physics Theory	
Particle Astrophysics and Cosmology	
Nuclear Physics	