Step 1 Evaluation Report

CONFIDENTIAL

Call reference	ERC-2020-STG
Activity	Starting Grant
Funding scheme	ERC STARTING GRANTS
Panel name	PE3
Proposal No.	945997
Acronym	MaMBA
Applicant Name	Petr ČERMÁK
Title	Magnetoelastic Materials beyond Born-Oppenheimer Approximation

EVALUATION CRITERIA

Criterion 1 - RESEARCH PROJECT
Ground-breaking nature and potential impact of the research project
To what extent does the proposed research address important challenges?
To what extent are the objectives ambitious and beyond the state of the art (e.g. novel concepts and approaches or development between or across disciplines)?
To what extent is the proposed research high risk/high gain (i.e. if successful the payoffs will be very significant, but there is a high risk that the research project does not entirely fulfil its aims)?

Scientific Approach
To what extent is the outlined scientific approach feasible bearing in mind the extent that the proposed research is high risk/high gain (based on the Extended Synopsis)?

Criterion 2 - PRINCIPAL INVESTIGATOR
Intellectual capacity and creativity
The questions below can have one of the following five responses: Exceptional/Excellent/Very Good/Good/Non-competitive
To what extent has the PI demonstrated the ability to conduct ground-breaking research?
To what extent does the PI provide evidence of creative independent thinking?
To what extent does the PI have the required scientific expertise and capacity to successfully execute the project?

PANEL SCORE AND RANKING RANGE

Final panel score: C (is not of sufficient quality to pass to Step 2 of the evaluation. Please note that you may also be subject to resubmission limitations in the next call)	**Ranking range*:** 84%-100% For your information, only the top 34% of the proposals evaluated in panel PE3 were retained for Step 2.

* Ranking range of your proposal out of the proposals evaluated by the panel in Step 1, in percent, from 1% for the highest ranked proposals to 100% for the lowest ranked.

PANEL COMMENT

This evaluation report contains the final score awarded by the ERC review panel during the first step of the ERC Starting Grant review and the ranking range. The discussion of the panel was conducted within the context of the individual reviews submitted by ERC panel members.

The panel closely examined all the individual review reports and, while not necessarily subscribing to each and every opinion expressed, found that they provide a fair overall assessment. The comments of the individual reviewers were the basis for the discussion and the final recommendation of the panel, and are included in this report.

The applicant is a recognized expert in very precise neutron scattering studies, advanced materials property-structure links, and he also has much experience with scientific instrument and software development. This proposal has the aim of demonstrating magneto-elastic interactions (interaction of lattice vibrations and electron spins) through inelastic neutron scattering studies on single crystal samples. Besides this scientific approach, the project proposes an automated device for constructing high quality ‘single crystal’ samples, as required for these studies, from smaller crystallites. The proposal lacks a clear scientific goal and clarity over the basic science questions to be tackled. The proposal also appears to have a somewhat unfocused approach, including two very separate tracks.

On the basis of this evaluation, the panel concluded that the proposal does not meet the excellence standards of the ERC. The panel therefore recommends that the proposal should not be retained for Step 2 and should not be considered for funding.

REVIEWER COMMENTS

The following individual reviews have been carried out independently prior to the panel meeting and do not necessarily reflect the panel's final opinion

Reviewer 1

Research Project
Ground-breaking nature and potential impact of the research project Magnetoelestic properties, in the form of general interactions between lattice vibrations and electron spin, will be studied. Such coupling is proposed to lead to novel states of matter, and hence diverse ground states and exotic modes. This will provide new insight and new perspectives on existing theories of solid state physics. The project involves the application of very precise methods for the observation of crystalline electric field – phonon coupling, through neutron scattering, and experimental verification of theoretical predictions. The predicted weak coupling effects, which are otherwise hidden, have been observed (by the applicant) using state-of-the-art equipment and high quality single crystal samples. There is a requirement for large crystal samples (~1 g), and this is where crystal co-alignment is necessary to piece together considerably smaller (mg) crystal pieces. A novel piece of equipment is to be built: an automated crystal aligner, using Laue diffractometry to orient the small crystals and position them in a single orientated sample. The development of a coupling theory is proposed, via strong collaboration with theorists. In further collaborations powerful simulations will be developed, and open source code published. **Scientific Approach** Significant effort is to be put into initial crystal growth, whilst development of the automated crystal aligner also takes place. The applicant comments upon the importance of this device succeeding in order for the project to succeed (and is “certain of its feasibility”), but we are not given any feel for the quality of the samples that it will produce. Will this be sufficient for the very demanding neutron characterization proposed, which is “the crucial part of the project”? The proposal states that the crystal aligner will “take several single crystals”. However, in order to go from mg samples up to the required scale will require hundreds. And what level of perfection can be achieved? Even boundaries between co-grown domains with a single-orientation in, say, an epitaxially grown film, represent defects observed through diffraction techniques. Neutron experiments and data evaluation begin in year 1 / 2; and yet the aligner is not constructed until year 3, with commissioning only complete in year 4. Which samples are to be studied in the early stages, and why is the aligner essential? This feels like two projects (requiring very different teams and experience), with some overlap. The theory / simulation / experimental links with collaborators is a great strength.

Principal Investigator	
To what extent has the PI demonstrated the ability to conduct ground-breaking research?	Very good
To what extent does the PI provide evidence of creative independent thinking?	Very good
To what extent does the PI have the required scientific expertise and capacity to successfully execute the project?	Very good

Comments (Optional for reviewers)
The applicant has experience in very precise neutron scattering experiments, and the development of novel theories to explain results, as well as instrument and software development. These all focus well onto the proposed work.

Reviewer 2

Research Project
Ground-breaking nature and potential impact of the research project This project aims at addressing magneto elastic effects in magnetic materials, using a new device to align crystal samples, whose realization is the only clear objective of the proposal. Other than this, I have not been able to identify a clear outstanding physical idea behind the project and a clear motivation of the applications to be pursued. The PI's insistence on the I have not been able either to understand whether the PI's insistence of non-adiabatic effects (beyond the Born-Oppenheimer approximation) was just motivated by the obvious importance of electron-phonon and electron-magnon effects or else if he intended to allude to more subtle effects (which ones?) **Scientific Approach** The workplan is a bit confusing presenting teams and scientific objectives on a same footing.

Principal Investigator	
To what extent has the PI demonstrated the ability to conduct ground-breaking research?	Very good
To what extent does the PI provide evidence of creative independent thinking?	Very good
To what extent does the PI have the required scientific expertise and capacity to successfully execute the project?	Very good

Comments (Optional for reviewers)
The PI is a research engineer with a very good publication record, consisting of ~25 peer reviewed papers ranked by WoS, which have earned him 140+ citations and ah H index of ~7. A couple of high-impact papers have been published, and he is the first author of more than one third of them. In Juelich and Grenoble he has helped develop different instruments and he has a good network of international collaborations (Germany, China).

Reviewer 3

Research Project
Ground-breaking nature and potential impact of the research project The project proposal is clearly written and includes all the important elements. Within the proposal, the candidate explains how he will experimentally prove that virtually all materials exhibit magnetoelastic coupling, creating new states in the matter and thus the B-O approximation is not justified. The author explains that the only method that can detect lattice vibrations and electronic levels in the material is inelastic neutron scattering, the method he is specialized in. The project will link some important research fields, such as monocrystalline sample preparation, the fabrication of a robotic arm that will allow small sample orientation for neutron spectroscopy studies and theoretical processing of experimental data. The project has novel concepts and is in some elements beyond the state of the art. The design and fabrication of a robotic arm and suitable software to use the arm have undoubtedly elements of high risk/high gain. **Scientific Approach** The described scientific approach looks feasible, the possible problems are suitably explained in risk analysis.

Principal Investigator	
To what extent has the PI demonstrated the ability to conduct ground-breaking research?	Very good
To what extent does the PI provide evidence of creative independent thinking?	Very good
To what extent does the PI have the required scientific expertise and capacity to successfully execute the project?	Very good

Comments (Optional for reviewers)
The candidate has a strong background in experimental techniques in the area of the proposal (inelastic neutron scattering). He has not been a PI of a bigger project and has no invited lectures at major conferences.

Reviewer 4

Research Project
Ground-breaking nature and potential impact of the research project The project aims at studying magneto-elastic effects in solid state platforms, where the Born-Oppenheimer approximation breaks down. It is expected that in that regime new excitation modes may emerge. The PI identifies directions where this study may be effective, e.g. the coexistence of magnetism and superconductivity, or structural distortions in pnictides. The motivation why such directions are interesting is convincing. However, given the huge body of work done in those frontiers, it is unclear on which facets this project may give rise to a significant thrust forward and why. **Scientific Approach** The structure of the project is clearly elucidated. However, what specifically will be done in each step (subproject), with concrete scientific questions, is missing here. Beyond this, to some extent it appears to be a collaborative project rather than a project led by one PI. The balance and coherency between the proposed experimental tools and the calculational ones are not sufficiently elaborated.

Principal Investigator	
To what extent has the PI demonstrated the ability to conduct ground-breaking research?	Very good
To what extent does the PI provide evidence of creative independent thinking?	Good
To what extent does the PI have the required scientific expertise and capacity to successfully execute the project?	Very good

Comments (Optional for reviewers)
The PI has a demonstrated experience in developing and maintaining laboratory tools and software. The impact of his research so far is quite modest.