Marie Curie - IEF application tips & tricks

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General Advice 1

- The Marie Curie Fellowships are an investment in the EU, not a gift to you.
- The Marie Curie Fellowships are aimed at personal careers. (This makes the scientific part less important than for a usual grant application).
- Make concrete plans and timelines (both for experiment and for personal career).

General advice 2

- The science part is not necessarily evaluated by specialists of your field: balance detail vs clarity.
- Use diagrams / pictures to make it easy for the reader to understand and like what you write about.
- Exaggerate structuring the document formatting (bullet points, tables, bold/italic text).
- Make sure to discuss what they ask about: they will give points 'checklist style'.
- Look at earlier proposals (but be individual!)
- Use referees

General advice 2

We will implement this lattice by forming a 2D superlattice (fig. 4) of two separate light fields which differ in periodicity by a factor of 2. In such a system, the relative depth of the wells in the unit cell can be controlled, and thereby also the number of atoms in each of the unit cell’s sites. The method that we plan to explore is as follows. The 2D double-well structures, also called “plaquettes”, are initially prepared in a band insulator configuration with N atoms per plaquette. This allows us to subsequently control the parameters n_A and n_B in a robust way by adiabatic changes of the potential. For detecting the resulting state, the analogue technique to [22] can be implemented for the generalized case by isolating plaquettes and determining the singlet fraction via band excitation. We initially plan to conduct these experiments on a single-plaquette basis in order to verify the techniques and to explore individual few-body SU(N) singlets. This is much less demanding than the bulk case in terms of low temperature requirements and a larger signal to noise ratio can be expected. Reaching the low temperatures required for observing spin correlations in the bulk 2D system will be a key question in the stages leading up to this experiment. It is however expected that the temperatures required for SU(N) spin correlations increase with larger N values, which would make these more accessible than with the usual SU(2) pseudospin systems for Alkali atoms. The interesting crossovers between different regimes are expected to occur for approximately N=4, (within the range of Yb, where N=6 can be reached).

Artificial gauge fields

Different proposals exist to create artificial gauge fields for ultracold atoms. Our implementation will mainly follow the proposal by Cooper [18]. With this approach, large magnetic fields can be reached with reasonable experimental complexity. In this case a 2D lattice is formed in the horizontal plane by laser fields with an anti-magical wavelength (fig. 5). The resulting potential leads to a staggered lattice of sites for *g* and *e* atoms. In the next step three propagating laser fields are introduced to the lattice, which are all close to resonance with the *g-e* transition, thereby forming dressed states. The local phase of the light field controls the phase of the dressed state of an atom moving between sites. By tuning the angle between the lasers forming the 2D anti-magical lattice and the coupling lasers, the lattice-spacing can be matched to an effective phase difference of π of the (traveling) coupling lasers. The orientation of the three coupling lasers is such that each atom traveling around a unit cell in the lattice picks up the same amount of phase, as would a charged particle in a homogeneous magnetic field. As this effective magnetic field has large values, this approach allows for reaching a field regime where integer and fractional quantum Hall effect physics is expected to be observable.

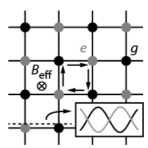


Figure 5. A lattice of anti-magic wavelength laser beams provides an alternating pattern of g and e sites. In combination with a laser field coupling the g and e states, this leads to an effective magnetic field through each lattice cell.

B1.3 Originality and innovative nature of the project, and relationship to the 'state of the art' of research in the field

Our research goals lie fundamentally in two areas of many-body physics: Firstly in the area of correlated spin physics related to quantum magnetism, and secondly in the physics of quantum systems in gauge potentials (magnetic fields). Both of these are at the focus of current research in ultracold quantum gases, as they promise to implement models for problems where important questions cannot be answered by other means so far. The most common state of the art approach of achieving one type of quantum magnetism – antiferromagnetism in the bare Fermi Hubbard model, pursued by several groups – has not yet succeeded, but the required temperatures seem within reach soon. Our plans to investigate

efficient evaporative cooling as demonstrated by the group of Y. Takahashi (Kyoto). Subsequently, the state-dependent optical lattice potentials are superimposed with the dipole trap in order to transfer the atoms to the lattice trap. The work plan for the following two years is outlined as follows. The scientific team will consist of the group leaders, Prof. I. Bloch and Dr. S. Fölling, one post-doc (myself), and at least two younger students. The different projects will be divided among the students, and will be mentored by S. Fölling and myself.

	Year 1	Year 2
Implementation of nuclear spin control		
Implementation of optical lattice		
Preparation of *g-e* states		
Characterization of setup		
SU(N) thermodynamics		
Extension to Kondo lattice		
Investigation of KLM phases		
Realization of double-well lattice		
Measurement of SU(N) phases		
Generation of anti-magic lattice with commensurate coupling field		
Characterization of eff. magnetic field		

The work plan is organized along 5 milestones. The first milestone is gaining the ability to control the state of the quantum gas as well as the required lattice properties. The other 4 milestones each represent a major achievement in the field of cold gases that would be suitable for publication.

Milestone 1 – Demonstration of control of nuclear spin state and optical access to meta-stable electronic excited state (6 months)

Implementation of optical pumping scheme for controlling nuclear spin state (1 month)

The first step after reaching quantum degeneracy with Yb atoms is the preparation of the desired (nuclear) spin configuration for the fermionic ^{173}Yb quantum gas. This is for example necessary to choose the value of N in the SU(N) symmetric nuclear spin system. For this we will use optical pumping via $^1P_1$ (blue laser) and $^3P_1$ (green laser) and resonant RF driving in the presence of a magnetic field to selectively address the different Zeeman levels, both before and after the evaporative cooling step. This work is expected to be in progress at the start of the Marie Curie fellowship.

Implementation of 2D and 3D lattice potentials suitable for both the ‘g’ and the ‘e’ states (2 months)

The creation of an optical trapping potential is a requirement for the later experiments. Once in place, it also simplifies some of the characterization procedures that are required to obtain some important parameters of ytterbium. We will start by generating a vertical confinement (pancake-shaped) 2D trap, which provides a trapping potential for both the electronic ground state ‘*g*’ and the metastable excited state ‘*e*’. Here, we will use a combination of hybrid optical potentials and selective lattice plane loading to achieve a system essentially comprised of a single 2D plane, applying techniques developed for the quantum gas microscope experiments [7]. This trap will then be extended to a full lattice system by adding the in-plane lattice potentials, initially close to the “magic” wavelength.

Ask Yourself

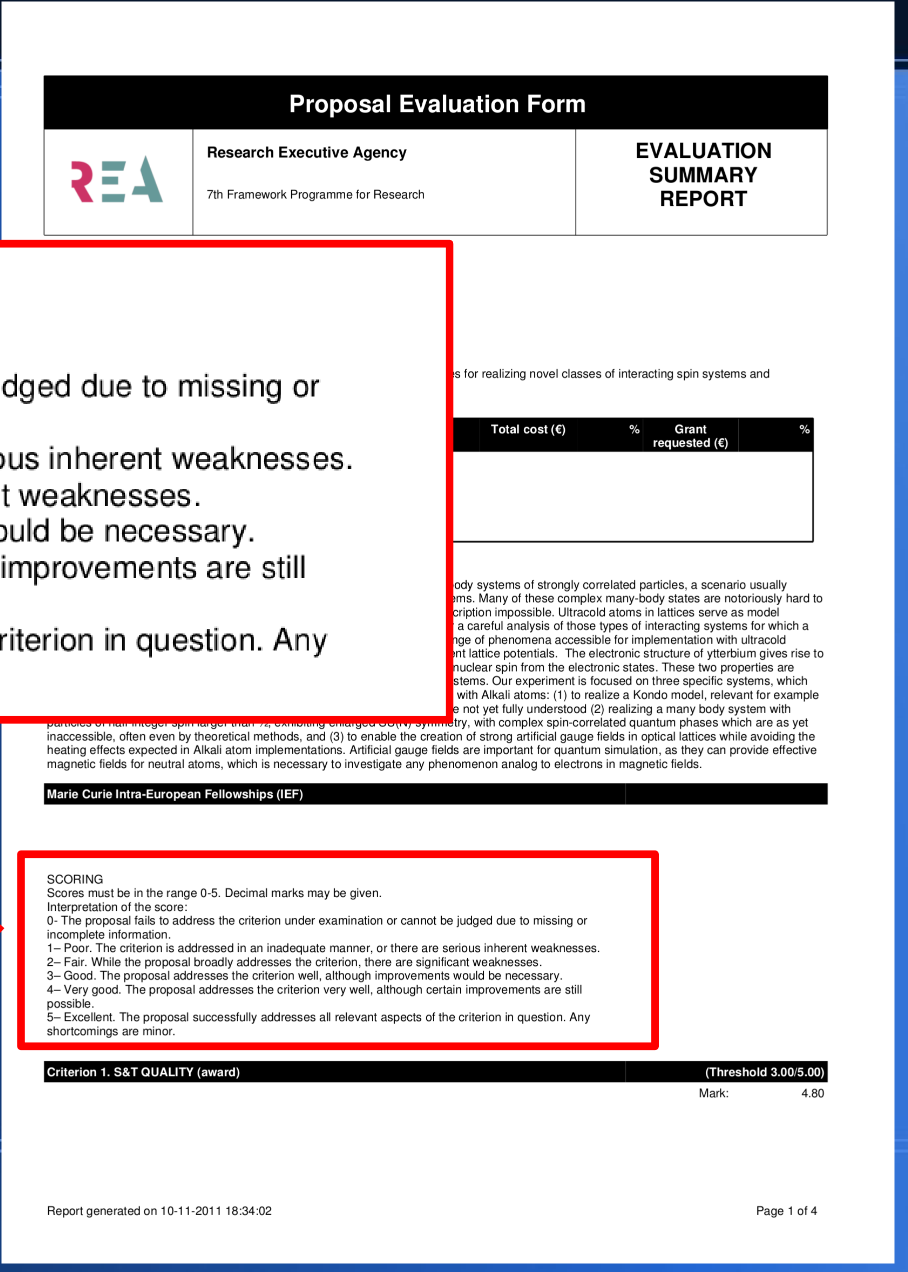
- What makes me a good choice for the EU to invest in? What is unique about me? Anticipate possible negative points (and possibly discuss). DON'T BE HUMBLE!
- What makes the host a good choice for your SPECIFIC plan?
- How is this going to affect my future AND that of the EU?
- What do THEY want to hear?

Categories

- Science and Technology quality (0.25)
- Training (0.15)
- Researcher (0.25)
- Implementation (0.15)
- Impact (0.20)

Scoring

SCORING
Scores must be in the range 0-5. Decimal marks may be given.
Interpretation of the score:
0- The proposal fails to address the criterion under examination or cannot be judged due to missing or incomplete information.
1– Poor. The criterion is addressed in an inadequate manner, or there are serious inherent weaknesses.
2– Fair. While the proposal broadly addresses the criterion, there are significant weaknesses.
3– Good. The proposal addresses the criterion well, although improvements would be necessary.
4– Very good. The proposal addresses the criterion very well, although certain improvements are still possible.
5– Excellent. The proposal successfully addresses all relevant aspects of the criterion in question. Any shortcomings are minor.



Proposal Evaluation Form

REA	Research Executive Agency 7th Framework Programme for Research	EVALUATION SUMMARY REPORT

...s for realizing novel classes of interacting spin systems and

...	Total cost (€)	%	Grant requested (€)	%

...ody systems of strongly correlated particles, a scenario usually ...ems. Many of these complex many-body states are notoriously hard to ...cription impossible. Ultracold atoms in lattices serve as model ... a careful analysis of those types of interacting systems for which a ...nge of phenomena accessible for implementation with ultracold ...nt lattice potentials. The electronic structure of ytterbium gives rise to ...nuclear spin from the electronic states. These two properties are ...stems. Our experiment is focused on three specific systems, which ... with Alkali atoms: (1) to realize a Kondo model, relevant for example ...e not yet fully understood (2) realizing a many body system with ...try, with complex spin-correlated quantum phases which are as yet inaccessible, often even by theoretical methods, and (3) to enable the creation of strong artificial gauge fields in optical lattices while avoiding the heating effects expected in Alkali atom implementations. Artificial gauge fields are important for quantum simulation, as they can provide effective magnetic fields for neutral atoms, which is necessary to investigate any phenomenon analog to electrons in magnetic fields.

Marie Curie Intra-European Fellowships (IEF)

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Criterion 1. S&T QUALITY (award) **(Threshold 3.00/5.00)**

Mark: 4.80

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Scoring

Criterion 1. S&T QUALITY (award)		(Threshold 3.00/5.00)
	Mark:	4.80
	Weight:	0.25

Strengths of the proposal:
- This is an excellent and highly relevant proposal, which addresses a novel subject of broad interest.
- The methodology is detailed and appropriate. The correspondence between the research objectives and the methods to be used to achieve them is excellent.
- The host institute and group are among the world-leaders in the field, and responsible for many of the main experimental advances. Several techniques that will be used in the proposed research have been developed at the host, their application to fermionic Yb being a main novelty.

Issues to be addressed when assigning an overall mark for this criterion:

- Research/technological quality, including any interdisciplinary and multidisciplinary aspects of the proposal
- Appropriateness of research methodology and approach
- Originality and innovative nature of the project, and relationship to the 'state of the art' of research in the field
- Timeliness and relevance of the project
- Host research expertise in the field
- Quality of the group/supervisors

Please use the following structure in your comments to this criterion:
- Strengths of the proposal (bullet point structure):
- Weaknesses of the proposal (bullet point structure):
- Overall comments:
(reflecting the relative importance of the strengths and weaknesses above mentioned)
(copy the text above in the comment box)

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Science and Tech. Quality

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Training

Criterion 2. TRAINING (award)

Strengths of the proposal:
- There are very clear research training objectives of high quality.
- The applicant has done his PhD in a different field of physics. The move to the physics of ultracold atoms will give him an opportunity to be trained in several new experimental techniques.
- The candidate will have excellent opportunities for acquiring complementary skills.
- The host has an excellent record of training PhD students and postdocs for successful future academic careers.

Issues to be addressed when assigning an overall mark for this criterion:

- Clarity and quality of the research training objectives for the researcher
- Relevance and quality of additional research training as well as of transferable skills offered, with special attention to exposure to the industry sector, where appropriate.*
- Host expertise in training experienced researchers in the field and capacity to provide mentoring/tutoring

Researcher

Criterion 3. RESEARCHER (award)

Strengths of the proposal:
- The applicant has very good research experience. However, the activities during the period between acquiring of the PhD in July 2010 and joining the host in May 2011 are not documented.
- The applicant has an excellent publication record, including one Nature and two Nature Physics publications.
- The applicant has some experience in undergraduate student supervision and teaching.
- The applicant has the potential to acquire new knowledge and skills.

Weakness of the proposal:
- The profile of the applicant only partially matches the proposed research activity.

Issues to be addressed when assigning an overall mark for this criterion:

- Research experience
- Research results including patents, publications, teaching etc, taking into account the level of experience
- Independent thinking and leadership qualities
- Match between the fellow's profile and project
- Potential for reaching a position of professional maturity*
- Potential to acquire new knowledge

Implementation

Criterion 4. IMPLEMENTATION (selection)

Strengths of the proposal
- The host has excellent infrastructure and an impressive network of international collaborations.
- An excellent and detailed work plan is presented. The project is credible and appears feasible.
- All necessary practical arrangements are already in place; the fellow is already working at the host site.

Weaknesses of the proposal
- Any risk analysis and related contingency plans are not presented.

Issues to be addressed when assigning an overall mark for this criterion:

- Quality of infrastructure / facilities and International collaborations of host
- Practical arrangements for the implementation and management of the research project*
- Feasibility and credibility of the project, including work plan
- Practical and administrative arrangements, and support for the hosting of the fellow*

Impact

Criterion 5. IMPACT (award)

Strengths of the proposal:
- The fellowship will significantly improve the applicant's skills, and advance his research career. Wanting to acquire a position of professional maturity would be premature at the present stage, due to the change of research area.
- The proposed research is likely to significantly contribute to European excellence.

Weaknesses of the proposal:
- The mobility aspect of this proposal is not entirely convincing since the candidate is already working at the host.
- The applicant is interested in participating in existing outreach activities at the host, but does not make a very strong commitment.

Issues to be addressed when assigning an overall mark for this criterion:

- Potential of acquiring competencies during the fellowship to improve the prospects of reaching and/or reinforcing a position of professional maturity, diversity and independence, in particular through exposure to transferable skills training with special attention to exposure to the industry sector, where appropriate*

- Contribution to career development or re-establishment where relevant*
- Contribution to European excellence and European competitiveness
- Benefit of the mobility to the European Research Area
- Impact of the proposed outreach activities*

Good Luck!