Acronyme	**HAM-MARK**		
Titre du projet en français	**Méthodes hamiltoniennes et markoviennes en mécanique quantique hors équilibre**		
Titre du projet en anglais	**Hamiltonian and Markovian methods for out of equilibrium quantum mechanics**		
CSD principale	☐ 1 ☐ 2 ☐ 3 ☐ 4 X 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9		
CSD secondaire ***(si interdisciplinarité)***	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9		
Aide totale demandée	272 250 €	**Durée du projet**	48 mois

SOMMAIRE

1. CONTEXTE ET POSITIONNEMENT DU PROJET / CONTEXT AND POSITIONNING OF THE PROPOSAL

The aim of this project is to enhence collaborations between researchers of international level on the development of two complementary approaches of rigorous statistical mechanics for quantum open systems.

There exist actually two different approaches, two different groups of researchers, in mathematics as well as in physics, which study the behaviour of dissipative quantum systems. They are: the Hamiltonian approach and the Markovian approach.

Up to the last few years the connections and collaboration between these two groups of researchers have been very poor. Their techniques are very different but the problems they study are exactly the same. It has been one the successes of some of the members of this A.N.R. project to initiate, 7 years ago, discussions and collaborations between these two groups. Already, concrete results have been obtained (common publications, developments of new tools, collaborations with physicists, ...).

The aim of this A.N.R. is to help this group of researchers to increase their cooperation in order to solve some of the most challenging problems connected to rigourous quantum statistical mechanics. In particular, we have in mind: the Fourier's law for heat transport on quantum systems, the description of non-equilibrium steady states for simple spin models, the development of quantum Lanvegin equation techniques in order to describe the action of quantum heat baths.

2. DESCRIPTION SCIENTIFIQUE ET TECHNIQUE / SCIENTIFIC AND TECHNICAL DESCRIPTION

2.1. ÉTAT DE L'ART / BACKGROUND, STATE OF THE ART

We wish to develop mathematical tools in order to understand the thermodynamical properties of quantum systems out of equilibrium. Indeed, despite the fact that the mathematical structure of equilibrium thermodynamics is well-understood, the situation is far from satisfactory out of the equilibrium regime. In contrast with equilibrium states which can be characterized in several ways (KMS condition, Gibbs property, DLR equation, variational principles, stability, dissipativity, etc.) there exists no satisfactory way of characterizing states out of equilibrium. The status of some phenomelogical characterizations (minimal entropy production) or some formal constructions (Zubarev-McLennan, Schwinger-Keldysh) are still rather mysterious. There are even more fondamental problems such as the validity of the Fourier law which is certainly one of the most important challenges of today's mathematical-physics.

The strategy we shall adopt is the one which emerged in the recent developments of the subject (Gallavotti, Ruelle, Lebowitz-Spohn, Maes, Derezinski, Attal-Pautrat, Jaksic-Pillet, ...). It is based on two different approaches.

• The interesting states out of equilibrium are those which are naturally selected by the dynamics of the system. The construction of such a state is thus based on the asymptotic study of the evolution of a class of initial states (reference states) which specify the forces acting on the system (temperature gradient, electro-chemical potential, etc). We speak of *Hamiltonian approach* when the study of this asymptotic behaviour is made on the complete dynamics of the coupled system S+R. The mathematical framework of this approach makes use of extremely elaborated tools. Indeed, the description of the reservoirs (with infinitely many degrees of freedom) makes use of the algebraic description of quantum mechanics (C*-algebras and von Neumann algebras). In particular, the Tomita-Takesaki modular theory plays a crucial role in the definition of a pertinent generator of the quantum dynamical system: the standard Liouvillian (Jaksic-Pillet 1996) close to equilibrium, the C-liouvillian (Jaksic-Pillet 2002) out of equilibrium. The first rigourous proof of return to equilibrium property (Jaksic-Pillet, Bach-Fröhlich-Sigal, Derezinski-Jaksic, Fröhlich-Merkli) are all based on a fine spectral analysis of the standard Liouvillian. The first results of existence of stationnary states out of equilibrium are even more recent (Jaksic-Pillet 2003) and extend this analysis to the C-Liouvillian. Alternatively, the Hamiltonian approach for fermionic systems or for spin systems can be achieved by algebraic scattering methods (Ruelle 2000, Fröhlich-Merkli-Ultschi 2003, Jaksic-Ogata-Pillet 2006) whose development is still extremely rudimentary.

• In some cases, by selecting in some appropriate way the time and the space scales, it is possible to obtain a reduced description of the Hamiltonian dynamics. The Markovian character of the effective dynamics of the small system, obtained this way, presents a great simplification and allows to treat models for which the Hamiltonian approach would be technically impossible to study. We speak of a Markovian approach when the non-equilibrium states are constructed from this effective dynamics. More generally, one can obtain a Markovian dynamics on S when giving up the idea to describe the environment R (either it is considered as being too complicated, or inaccessible or simply unknown). One then replaces the effects of the interactions of the small system S with its environment by quantum noises. The evolution equation of the system become a quantum stochastic differential equation whose solution, a quantum Markov process, induces a semigroup of completely positive maps on the observables (or the states) of the small system. Mathematically, this semigroup has the same structure as the one obtained by a scaling limit on the Hamiltonian system. Its generator, the Lindbladian, presents, in the same way as the generator of a usual Markov process: a first order differential part (which carries the natural dynamics of the small system) and a second order differential part (which carries the dissipation of the small system in favour of the environment). Actually, to be more precise, this second order part carries a diffusive part (this is the true second order part) but also a ''jump'' part, like the jump measure part associated to the general Feller semigroups. The tools for studying the convergence of such systems are then of the type of those used for usual Markov processes (recurrence-transience, invariant measures, potential theory, spectral gap, Sobolev inequalities, ...)

The relations between these two approaches are for the moment rather poor, we feel that we need to develop them both. But the link between them is clearly natural and surely source of important results. For example, the spectral analysis of the C-Liouvillian requires a study of the spectrum of the Lindbladian obtained in the weak-coupling limit. Conversely, the Markovian dynamics can be associated to a Hamiltonian dynamics by the construction of a unitary dilation of the Lindblad semigroup (Attal-Pautrat, Derezinski-De Roeck). In some cases the two approaches match: a model of repeated quantum interactions (Attal-Pautrat) allows to exhibit a dynamics which is at the same time Hamiltonian (time-dependent) and Markovian. In a certain limit (continuous interaction limit) it converges to a quantum stochastic differential equation (a quantum Langevin equation) (Attal-Pautrat 2003). This model has allowed to validate a definitive form for the Langevin equation associated to the action of a quantum heat bath (Attal-Joye 2006). These repeated quantum interactions models, are physically relevant as they correspond to effective experiments in quantum optics. Mathematically, they have given rise to several recent developments (Bruneau-Joye-Merkli, Bruneau-Pillet).

2.2. OBJECTIFS ET CARACTÈRE AMBITIEUX/NOVATEUR DU PROJET / RATIONALE HIGHLIGHTING THE ORIGINALITY AND NOVELTY OF THE PROPOSAL

The originality and the great force of the project lies into the fact that it proposes to make collaborating different group of researchers which are not usually working together. First of all, this project proposes to make different groups of researchers collaborate which are not usually : those working with the Hamiltonian approach, together with those who work with the Markovian approach.

The tools are very different: operator algebras, spectral analysis on one hand and stochastic calculus, Markov processes on the other hand. These are very different techniques, working in the same direction (understanding the behaviour of quantum statistical systems). This is certainly a great force for the development of the research in this field if such different tools can be made working together.

One very important point to be noted about this collaboration, is that there is no other team, no other group in the world which can propose such a collaboration, such a complementarity. The very first connections between these groups of researchers were initiated by some of the members of this A.N.R. project, some 6 or 7 years ago (S. Attal, A. Joye, Y. Pautrat, C.-A. Pillet). They have been the starting point of very new tools on the subject. Secondly, the A.N.R. project we present here is original for it includes a true collaboration between mathematicians and physicists. There are two physicists (Karevski and Platini) in the group and there exists several other collaborations with physicists, outside of this project. This proves that our work and project contain not only deep mathematical and conceptual developments, but also applications to concrete physical situations.

3. PROGRAMME SCIENTIFIQUE ET TECHNIQUE, ORGANISATION DU PROJET / SCIENTIFIC AND TECHNICAL PROGRAMME, PROJECT MANAGEMENT

3.1. PROGRAMME SCIENTIFIQUE ET STRUCTURATION DU PROJET / SCIENTIFIC PROGRAMME, SPECIFIC AIMS OF THE PROPOSAL

We shall here develop the different parts of the scientific program that we would like to achieve during this A.N.R. program.

a) Dynamics and statistical mechanics of open quantum systems.

We want to pursue the study of structural properties of non-equilibrium steady states (NESS). It is a project, which we are working on for several years with a certain success. Our approach is multiple:

-- On the one hand we would like to mathematically justify some of the formalisms commonly used by the physicists, in particular in the domain of nanoscopic physics: Green-Kubo formula, Buettiker-Landauer formula, Meir-Wingreen formula, Schwinger-Keldish formalism, Zubarev-McLennan formalism, etc...

-- On the other hand we would like to develop, in the framework of quantum statistical mechanics, some probabilistic concepts which are already strongly structuring the classical statistical mechanics: central limit theorems and large deviation principles. This step will allow us to generalise to the quantum setup very important recent results like the Gallavotti-Cohen fluctuation theorem. We also hope to open a new research direction with the study of repeated quantum interaction models (see Section b).

-- From a mathematical point of view, the study of the dynamics of open systems, in order to understand the structure of NESS, brings up new problems in spectral analysis and diffusion theory: limit absorbtion principle for non-selfadjoint operators, resonances for such operators, etc...

Our experience is important in this domain where we have shown all the benefit which is possible to obtain by crossing our efforts on the two fronts: classical and quantum mechanics. Though the techniques used in the two contexts are usually very different, they are based on conceptually similar approaches. For example the use of the C-Liouvillian in our approach of the NESS (Jaksic-Pillet) for quantum open systems, derives directly from the construction of SRB measures in classical dynamical systems by the Ruelle-Perron-Froebenius operator. Hence we will pursue, in parallel with the study of quantum NESS as explained above, the study of their classical counterparts. The unified competencies in this project should allow us to make important progresses in the stochastic modelisation of open systems.

b) Repeated quantum interactions

This is a model which appears naturally in the mathematical analysis used to describe the markovian approach of open systems, as well as a realistic model of quantum optics experiments already made in laboratories for 20 years. It consists in a reference system put into contact successively, during a fixed interval of time, with an infinite chain of identical sub-quantum systems. In quantum optics, the one atom maser is made of laser cavity with two windows crossed by a constant flux of atoms. The reference system is then a mode of the electromagnetic field, the elements of the chain are the atoms crossing the cavity.

The interest for this mathematical model has been recently renewed with the proof (Attal-Pautrat) that in the continuous interaction limit (interaction time going to 0) this (time-dependent) Hamiltonian dynamics is spontaneously converging to a quantum Langevin equation (a quantum stochastic differential equation, more precisely). This model, though being very simple, possesses non-trivial properties: it is at the same time Hamiltonian and Markovian, it possesses in the infinite time limit asymptotic states which are independent of the initial state and which show a positive entropy production, which is the sign of a NESS (Bruneau-Joye-Merkli), it allows to compute the quantum stochastic differential equation associated to the action of a quantum heat bath (Attal-Joye).

In the near future we will be considering the following problems attached to these models.

- In order to be more physically realistic some randomness is introduced in the description of the chain. The effective dynamics on the small systems is then given by a product of random matrices, of which we have to compute the asymptotics.
- The fact we have obtained the Langevin equation for a quantum heath bath with this model, pushes to consider models of systems where we can try to test the validity of the Fourier law: the small system is a chain (of spins for example, or harmonic oscillators) and it is coupled to two heath baths with different temperatures.
- These systems, in the discrete and continuous time, are connected to a very important research subject: the quantum trajectories. That is, the Monte-Carlo simulation of the master equation which is obtained by measuring some observable of the chain. Some recent very important results have been obtained by Pellegrini which show for the very first time the existence, uniqueness and physical validity of these equations. This is clearly a direction of research which is now emerging and that we shall further explore.

c) Time-scales

When studying problems connected to non-equilibrium quantum statistical mechanics, such as:

-- linear response theory (asymptotic states weakly out of equilibrium, response of the system to a gradient of temperature of electric field, ...)

-- spin chains (correlations, coupling to several baths, entropy production, ...)

-- decoherence processes and their applications to quantum information theory
there are several mathematical approaches and they correspond to different time scales in which one studies these systems.

-- In the asymptotic regime of infinite times, that is, t>>lambda^{-2}, where lambda is the coupling constant between the system and the bath. The pionner works of Jaksic and Pillet have allowed to bring back the problem of return to equilibrium to a spectral problem on the C-Liouvillian, which generates the system-bath dynamics in some appropriate representation. For lambda sufficiently small one can show the return to equilibrium (Derezinski-Jaksic-Pillet, Frohlich-Merkli, Merkli). Bruneau, Joye et Merkli have also used this approach to show the existence of asymptotic states for repeated interaction systems.

-- In the regime of long times but of order lambda^{-2}, the van Hove limit (or weak coupling limit) allows to bring the quantum problem back to a problem of classical random walk (in the limit lambda tends to 0). Davies has justified this approach in the 70's if the Hamiltonian of the small has a discrete spectrum. One should be able to extend these results to the case of extended systems with pure point spectrum and with sufficiently localized eigenfunctions. Introducting an electric field makes resonances appear, we would like to show that the weak coupling limit also exists in this case.

--In the regime of small times (in comparison with the caracteristic time of the isolated system), one can study the decoherence effects, by using an approach like Strunz-Haake-Braun. Even if this approach has not yet been written under a rigorous form, it has allowed Spehner and Haake to determine recently the decoherence times in a process of physical measurement. This opens up new perspectives in the study and the control of decoherence.

Another aspect of our interests in relation with time scales is the adiabatic study of time-dependant Lindbladian. Indeed, in the Markovian approach on quantum open systems, the effective dynamics of the small system is described by a quantum master equation, whose generator is a so-called Lindbladian. In many physically relevant situation this Lindbladian is time-dependent. This general case is too difficult to be handled in full generality, but when the time dependence is slow, one can use results and techniques from adiabatic theory (Joye). So far, only general abstract results have been derived, we wish to apply them to concrete systems of physical interest (e.g. Sarandy-Lidar in quantum optics). We also wish to describe

Hamiltonian situations and asymptotic regimes in which time-dependent Lindbladian emerge from the Nakajima-Zwanzig equations (time convolutionless projection operator techniques) . It has to be noticed that the preparation of qubits in experimental physics is actually performed by means of adiabatic techniques.

d) The XY-chain

One of the simplest non-trivial model for the study of non-equilibrium quantum statistical mechanics, is the model of a XY quantum spin chain with anisotropic coupling between the nearest neighbors. Despite its extreme simplicity this model admits several advantages (cf the recent article by Aschbacher and Pillet):

1) It is a good model in order to recover the non usual transport properties that have been discovered numerically and experimentally in magnetic system s of small dimension.
2) It allows to test some general ideas on the mathematical structure of models in non-equilibrium quantum statistical mechanics.

One of the aspects we should like to develop is to study how the correlations decrease in the non-equilibrium states. The folkore says that if we have an exponential decay at equilibrium, at positive temperature, one should get long range decay out of equilibrium.

The recent study (Aschbacher-Barbaroux) of an XY-model made of two half spin chains coupled in one point, representing a small system coupled to two different heat baths, has shown that, in contrast with the folklore, we obtain an exponential decay for the spin-spin correlations, for a non-equilibrium state. Hence several questions have naturally arised from these observations:

- In which circumstances do the correlations of some observables decrease exponentially? Can we connect this property with the spectral properties of the 2-point correlation operator?

- Can we exhibit a model for which one could obtain a polynomial decay of the correlations?

- Studying multidimensional models: for example 2-dimensional half-plane nets of spins coupled along a line. Can we again construct a non-equilibrium state and study its dynamical properties?

- A recent collaboration between Attal and Karevski has started in order to compute the behavior of an XY-chain put into a non-equilibrium situation but for small times: the XY-chain is in contact with one or several baths, at its extremity, the bath being modeled by a repeated interaction model made of another XY-chain at thermal equilibrium.

e) Collaboration with the physicists of the L.P.M., Nancy

The main aspects that the group of physicists from the Laboratoire de Physique des Matériaux de Nancy are developing are:

1. the dynamics of quantum open systems, the description of out equilibrium phenomenons (for example, the evolution of the intrication entropy out of equilibrium);
2. the influence of inhomogeneities on the properties of quantum open systems.l

For several years, this group has developed a systematic study of out of equilibrium dynamics for quantum spin chains coupled to quantum environments. Their attention has been focalized essentially on integrable chains for which an Hamiltonian approach is possible. Note that these models can also be interpreted in the framework of Bose condensation, for the Hamiltonians of these quantum chains can also describe hardcore boson assemblies (M Rigol, A Muramatsu and M Olshanii, Phys. Rev. A 74, 053616 (2006)).

In our collaboration project with them we will focus on spin chains locally coupled to thermal heat baths modeled by repeated interaction schemes. In this context we shall study the relaxation properties of a system in contat with one or several baths. We hope to characterize their stationnary states, their currents, their fluctuations, in order to extract their generical properties. The characterization of these states would allow to study many interesting physical situations, such as the quenched dynamics of quantum systems going through a critical point.

The axis 2) can be seen as the extension to out of equilibrium situations of many studies which have been developed in this Nancy team on phase transitions in aperiodic systems, desordered systems, inhomgeneous confined systems. Indeed, the presence of inhomogeneities can lead to a drastic change of the critical behaviour and give rise to exceptional behaviours such as log-periodic oscillations, infinite dynamical exponants, Griffiths phases, essential singularities, ... The systematic study of the influence of these perturbations on out of equilibrium properties, in particular on the relaxation of dissipative systems, is of main importance for the understanding of real physical systems in which purity and homogeneity is unreachable.

3.2. COORDINATION DU PROJET / PROJECT MANAGEMENT

The three main words which can characterise our action during this project could be: communication, education, mobility.

Indeed, the scientific program we have developed above implies for all of us an enormous investment in this project. In particular, the success of this ANR will be based on our capacity to communicate , to collaborate, to transmit information. Our approach being mainly based on the confrontation of different cultures, different knowledge, different techniques.

As was written above, our research topics requires from the researchers a very large basis of knowledge:

-- quantum mechanics
-- classical mechanics
-- statistical mechanics
-- operator algebras
-- modular theory
-- spectral theory
-- Markov processes
-- Stochastic calculus and Stochastic differential equations
-- quantum probability and quantum stochastic calculus.

For our students in particular it is quite a hard task to be able to produce new results in such an demanding subject.
Hence we need to have the possibility to be as mobile as possible, to give us many opportunities to learn new subjects, new material, to make all the possible collaborations exist without obstacle.

We think that concretely our activity during the 4 years of the contract will be organised as follows.

- At the begining of the project, in september 2009, the partner 2 will organise a meeting in Grenoble for all the members of the project. This meeting will last 3 days (2 nights) and aims at:

-- putting together all the open questions we want to consider during the project,

-- organising all the possible collaborations inside the group,

-- organising the first invitations for foreign researchers.

- In each geographical site of the partners will be organised a regular seminar (or workgroup) by the members of the local group. This will last for the whole duration of the contract. This seminar is the place where the researchers inside a group will:

-- invite collaborators to give talks or courses,

-- present their results, progresses or questions,

-- the doctoral student will have an opportunity to first present their work.

- Each member of the project will travel a lot in France and outside during the duration of the contract. These travels will be of three types:

-- one visit, each year to each of the other partners. This is the opportunity of making the collaborations work well, of sharing the knowledge, the results, the questions.

-- one visit, each year in one European country. This is to help the researchers to easily meet some specialist abroad who might help in specific questions, this might be the occasion of gaining more material for the success of the project, this might also be the occasion for the youngest to participate to congresses or schools abroad.

-- one travel, once in the 4 years, outside Europe, for the same reasons as developed above.

- Each partner team will buy the material that should help the education, the communication and the mobility for the members of the group. This means:

-- decent material for organizing the seminars, the conferences, the courses: video-projector, laser printer, scanner

-- a minimal amount for each researcher to be able to buy books for himself, in order to be able to carry his (her) research in the best conditions possible, in order to allow the students to afford those expensive books they always need.

-- computer material helping the mobility of the researchers : portable computers, supplementary hard discs and batteries.

- Two intermediate mini-conferences will be organised during the period of 4 years. Each of them will gather all the researchers involved in the project. Each mini-conference will last 3 days (2 nights). They will take place after 1,5 years and after 3 years, in Paris and Marseille respectively.

They are the occasion for all the members of the project to have a complete overview of the results, of the problems, of the situation of the group with respect to the goals we had defined in the project. They should be very important steps in this project.

- A final international conference will be organized in Lyon at the end of the project. This conference will no longer concern only the members of the A.N.R. project, but we will also invite an important number of international specialists. The aim of this conference is to make a complete tour of the results and the progresses in the subject during the last years. It will be the occasion for all the members of the A.N.R. project to present, in front of the main international specialists, the results and the successes of this project.

3.3. DESCRIPTION DES TRAVAUX PAR TÂCHE / DETAILED DESCRIPTION OF THE WORK ORGANISED BY TASKS

Cf Tableau ci-dessous

3.4. CALENDRIER DES TACHES, LIVRABLES ET JALONS / PLANNING OF TASKS, DELIVERABLES AND MILESTONES

Calendrier prévisionnel des tâches à réaliser

Tâches prévues	n° des partenaires	Date de début, durée	Ojectifs
Rencontre à Grenoble de tous les membres du projet A.N.R.	Tous les partenaires sont présents. Organisation : partenaire 2	Septembre 2009, durée 3 jours	Démarrage du projet, mise au point entre tous les membres du projet des objectifs, des collaborations, des chercheurs à inviter.
Mise en place des groupes de travail ou séminaires spécifiques.	Chaque partenaire	Octobre 2009, pour toute la durée du contrat.	Lieux d'échange et de communication pour chaque partenaire, lieu où viennent parler les invités extérieurs ou les membres du projet, lieu de formation principal des doctorants.
Achat des livres	Tous les partenaires	Octobre-Décembre 2009	Il s'agit pour chaque partenaire de mettre en place les moyens nécessaires à une bonne réussite de la formation de ses membres.
Voyages des membres du projet au sein des différents sites des autres partenaires.	Tous les partenaires	Janvier 2010, pour toute la durée du contrat.	C'est la mise en place, ou la continuation, des collaborations entre les membres du projet. C'est l'essence même du projet.
Invitations de partenaires européens ou hors Europe	Tous les partenaires	Octobre 2009, pour toute la durée du contrat	Un ingrédient important du renouvellement de l'activité scientifique de chaque partenaire : faire venir pour des séjours de moyenne durée des chercheurs étrangers spécialistes des domaines concernés.
Achat du matériel informatique nécessaire à la mobilité des chercheurs	Tous les partenaires	Etalé sur l'ensemble de la durée du contrat, selon les nécessités de chacun.	Les moyens informatiques, en particulier portables sont des ingrédients essentiels de la mobilité et de la communication des chercheurs. Ils sont l'outil de travail quotidien pour tous.

Tâches prévues	n° des partenaires	Date de début, durée	Ojectifs
Deuxième rencontre entre tous les membres du projet, à Paris	Tous les partenaires sont présents. Organisation : partenaire 1.	Janvier 2011, durée 3 jours	1 an et demi après le démarrage du projet, les chercheurs font le point sur les collaborations en cours, les projets de recherche qui viennent de démarrer, les premiers résultats, les premières pistes.
Voyages des membres du projet à l'étranger.	Tous les membres	Septembre 2010, pour 2 ans environ.	En plein coeur du projet, les chercheurs impliqués vont chercher auprès de partenaires étrangers (européens ou non) des possibilités de collaborations, de recherche d'information, de formation.
Troisième rencontre entre tous les membres du projet, à Marseille	Tous les partenaires sont présents. Organisation : partenaire 2	Septembre 2012, durée 3 jours.	Le projet est entamé depuis 3 ans. Cette mini-conférence permet de faire le point sur les résultats obtenus, sur les projets à achever.
Colloque international de cloture du projet, à Lyon	Tous les membres sont présents, plus de nombreux invités étrangers. Organisation : partenaire 1	Juin ou juillet 2013, durée 5 jours	Il s'agit d'un colloque international de grande envergure, rassemblant tous les plus grands spécialistes mondiaux des domaines de recherche concernés. Il est l'occasion pour les membres du projet ANR de présenter à la scène scientifique internationale, l'ensemble des résultats obtenus grâce au projet ANR.

4. STRATEGIE DE VALORISATION DES RESULTATS ET MODE DE PROTECTION ET D'EXPLOITATION DES RESULTATS / DATA MANAGEMENT, DATA SHARING, INTELLECTUAL PROPERTY AND RESULTS EXPLOITATION

In mathematics there is no much to deal with intellectual property, results exploitation, data management or data sharing problems. Though, we can insist here on the fact that our project contains a very important part devoted to the communication of the results (in particular the final international congress, at the end of the project), to the mobility of the researchers and their communication with foreign collegues. This clearly means that our intention is to valorise as much as possible the results we shall obtain with the help of the A.N.R. project.

Even if this is not included in the project, in order not to make the financement too heavy, we would like if possible, near the end of the project, to organize an international summer school, directed toward graduate students, in which we can diffuse the different techniques and progresses we have obtained in this challenging subject.

5. ORGANISATION DU PARTENARIAT / CONSORTIUM ORGANISATION AND DESCRIPTION

5.1. DESCRIPTION, ADÉQUATION ET COMPLÉMENTARITÉ DES PARTENAIRES / RELEVANCE AND COMPLEMENTARITY OF THE PARTNERS WITHIN THE CONSORTIUM

It is to be noted from the informations given above (vitae, list of publications, etc .) that all the researchers involved in this project are all internationally recognized specialists of one or the other areas concerned by the project. All the senior researchers involved are leaders in their domain, they have brought important contributions to the classical or quantum theory of open systems. The young researchers are all very bright and very active, they present impressive vitae already, they constitute a group of very mature researchers. One can also notice that the group we present for this A.N.R. is quite young (36 years old on average)

It is to be noted that almost all of them have given a full percentage of their time to this project, which shows that they are all fully actors of this domain of research, that they all feel completely invested by this project.

Another important point to be noted concerning the team involved in this project is that they already have many collaborations and that these collaborations are all recent. Indeed, one can notice on the list of published articles, the following collaborations :
-- Attal-Pautrat, 2 articles
-- Attal-Joye, 2 articles
-- Attal-Joye-Pillet, 3 books
-- Joye-Bruneau, 3 articles
-- Pautrat-Pillet, 2 articles
-- Bruneau-Pillet, 1 article

Some more collaborations have already started, with works in progress :
-- Attal-Karevski-Platini

All these researchers were not collaborating at all 7 years ago.

5.2. QUALIFICATION DU COORDINATEUR DU PROJET / QUALIFICATION OF THE PROJECT COORDINATOR

Stéphane Attal is an internationally recognized researcher in the domains of quantum stochastic calculus, applications of quantum probability techniques to quantum statistical mechanics etc … Together with Yan Pautrat (a former student of his) he has developed the « repeated quantum interaction models » and their links with quantum Langevin equations and quantum noises.

His last PhD student, Clément Pellegrini, has recently obtained the EADS annual price for the « Year best thesis in Mathematics and Applications ».

Together with Alain Joye and Claude-Alain Pillet, he has been initiating 6 or 7 years ago, this collaboration between the two different approaches of quantum open systems : the Hamiltonian and the Markovian approaches. Many research developments, many results and publications have been obtained since then.

He has organized (and co-organized) two international summer schools : 3 weeks, 80 participants, 20 nationalities, each time, with publication of the proceedings (5 volumes).

He has been head of two important exchange programs : a CEFIPRA exchange program in between France and India for 4 years (total amount : 50.000 €) and an ECOS exchange program in between France and Chile for 4 years (total amount : 30.000 €).

He has been, during 3 years, associated-director of the Institut Camille Jordan, one the 3 largest mathematics department in France and he is head, for 4 years, of the « Probability, Statistics and Mathematical Physics » team (25 permanent researchers).

5.3. QUALIFICATION, ROLE ET IMPLICATION DES PARTICIPANTS / CONTRIBUTION AND QUALIFICATION OD EACH PROJECT PARTICPANT

5.3.1 PARTENAIRE 1 = COORDINATEUR DU PROJET (GESTION BASEE SUR LYON)

	Nom	Prénom	Emploi actuel	%de temps consacré au projet	Rôle/ Responsabilité dans le projet
Coordina-teur	ATTAL	Stéphane	PR	100	Coordinateur du projet, Interactions répétées, équations de Langevin quantiques
Autres membres	BRUNEAU	Laurent	Mcf	100	Interactions répétées, systèmes classiques dissipatifs
	KAREVSKI	Dragi	Mcf	100	Chaines XY hors équilibre, comportements à temps courts
	PAUTRAT	Yan	Mcf	100	Interactions répétées, théorèmes central limites quantiques
	PELLEGRINI	Clément	Post-Doctorant	100	Trajectoires quantiques
	PLATINI	Thierry	Post-Doctorant	100	Chaines XY hors équilibre, comportements à temps courts

Partenaire 2 (Gestion basée sur Marseille)

	Nom	Prénom	Emploi actuel	% de temps consacré au projet	Rôle/Responsabilité dans le projet 4 lignes max
Responsable	PILLET	Claude-Alain	PR	100	Méthodes hamiltoniennes en mécanique statistique quantique, dynamiques hors équilibre
Autres membres	JOYE	Alain	PR	100	Interactions répétées, comportements asymptotiques en mécanique quantique
	BARBAROUX	Jean-Marie	MCF	50	Théorie quantique des champs, mécanique statistique hors équilibre
	SPEHNER	Domini-que	MCF	100	Théorie quantique de l'information, décohérence
	BEN SAAD	Rym	Post-Doc	100	Transport pour les systèmes quantiques ouverts
	VARGAS	Rodrigo	**Docto-rant**	100	Interactions répétées
	VOGELSBERGER	Sylvain	**Docto-rant**	100	Théorie quantique de l'information, décohérence

6. JUSTIFICATION SCIENTIFIQUE DES MOYENS DEMANDES / SCIENTIFIC JUSTIFICATION OF REQUESTED BUDGET

Les calculs des demandes de moyens sont effectués sur les bases suivantes :

Besoins informatiques : pour chaque chercheur (Equivalent Temps Plein), sur l'ensemble de la durée du projet : un ordinateur portable + petit matériel de mobilité (batterie supplémentaire, disque de sauvegarde, ...) : 2500 € HT

Achats de livres : pour chaque chercheur (Equivalent Temps Plein) un budget d'achat de livres scientifiques de 250 € HT par an, soit 1000 € HT sur la durée du contrat.

Pour les mini-conférences et le colloque final, comme pour les missions et invitations : la base de calcul est la suivante (coût moyen)

- Voyage A-R d'un chercheur résidant en France : 200 €
- Voyage A-R d'un chercheur résidant dans un autre pays européen : 500 €
- Voyage A-R d'un chercheur résidant dans un autre continent : 1000 €
- Séjour d'un chercheur (1 nuit d'hôtel + 2 repas) : 100 € par jour

Budget Missions : pour chaque chercheur (Equivalent Temps Plein) un budget mission permettant:

- chaque année : 1 voyage + 1 séjour de 3 jours dans 2 autres sites du projet : 4x1000 €=4000 €
- 2 fois sur la durée du contrat : 1 voyage + 1 séjour de 5 jours dans un autre pays européen : 2x1000 €=2000 €
- 1 fois sur le durée du contrat : 1 voyage et un séjour de 15 jours hors Europe, 1 seule fois sur la durée du contrat : 2500 €.

Total sur 4 ans : 8500 € par chercheur ETP

Budget Invitations : pour chaque chercheur (Equivalent Temps Plein) la possibilité d'inviter

- chaque année : 1 chercheur résidant en France pour 3 jours : soit 4x500 €=2000 €
- 2 fois dans la durée du contrat : 1 chercheur européen pour 5 jours : soit 2x1000 €= 2000 €
- 1 fois dans la durée du contrat : invitation d'un chercheur hors Europe pour 15 jours : 2500 €

Total sur 4 ans : 6500 € par chercheur ETP

6.1. PARTENAIRE 1 / PARTNER 1

Partenaire 1 (Lyon)

Nombre de chercheurs ETP : 6

Budget informatique : 15000€

Budget livres : 6000 €

Budget missions : 51000 €

Budget invitations : 39000 €

Organisation de la mini-conférence 2 (janvier 2011, durée 3 jours) : 5000 €
(Français : 500x10=5000 €)

Organisation de la conférence finale (juin 2012, durée 5 jours) : 27000 €
- Français : 600x15=9000 €
- Européens : 900x10=9000 €
- Hors Europe : 1500x6=9000 €

Total partenaire 1 : 143 000€

6.2. PARTENAIRE 2 / PARTNER 2 :

Partenaire 2 (Marseille)

Nombre de chercheurs ETP : 6,5

Budget informatique : 16250 €

Budget livres : 6500 €

Budget missions : 55250 €

Budget invitations : 42250 €

Organisation de la mini-conférence 1 (Septembre 2009, durée 3 jours) : 4500 €
(Français : 500x9=4500 €)

Organisation de la mini-conférence 3 (septembre 2011, durée 3 jours) : 4500 €
(Français : 500x9=4500 €)

Total partenaire 2 : 129 250€

7. ANNEXES

7.1. REFERENCES BIBLIOGRAPHIQUES / REFERENCES

7.2. BIOGRAPHIES / CV, RESUME

ATTAL Stéphane, *coordonnateur du projet.*
40 ans
Parcours :
Chargé de Recherche au C.N.R.S. en 1993
Doctorat en 1994 à Strasbourg,
H.D.R. en 1997 à Grenoble,
Professeur à l'Université de Lyon 1 en 2004.
Actuellement Professeur 2nde classe à Lyon 1

Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années

- S. ATTAL et Y. PAUTRAT, 2006, "From repeated to continuous quantum interactions", Annales Henri Poincaré, vol 7, p. 59-104.
- S. ATTAL et Y. PAUTRAT, 2005, "From (N+1)-level atom chains to N-dimensional noises", Annales de l'I.H.P. Probabilités et Statistiques, vol 41, p. 391-407.
- S. ATTAL et A. JOYE, 2007, "Weak coupling and continuous limits for repeated quantum interactions", Journal of Statistical Physics, 126 (2007), p. 1241-1283.
- S. ATTAL et A. JOYE, 2007, "The Langevin equation for a quantum heat bath", Journal of Functional Analysis,. 247, (2007), p. 253-288.
- S. ATTAL, 2003, "Approximating the Fock space with the Toy Fock space", Séminaire de Probabilités, vol XXXVI, p. 477-497.

Nombre total de publications : 31
+ 1 acte de conférence avec comité de lecture
+ 5 prépublications soumises
Co-direction d'ouvrages : 5 volumes.

Autres expériences d'encadrement de projets :

- Responsable d'un projet de coopération franco-indien CEFIPRA, durée 4ans (1999-2003), budget environ 100 000 €
- Responsable d'un projet de coopération franco-chilien ECOS, durée 4 ans (2002-2006), budget environ 20 000 €
- Organisateur de deux écoles d'étés internationales (80 participants, 3 semaines de cours, publications intégrales des actes sous forme de 5 volumes au total).
- Co-créateur et éditeur en chef du journal de publications mathématiques « Confluentes Matematici », éditée par World Scientific.

BRUNEAU Laurent
Né le 07 Septembre 1976 à Lille

Cursus:
Sept. 1995-Aout 1999: Elève à l'Ecole Normale Supérieure de Cachan
Sept. 1998-Déc. 2002: Thèse de Doctorat à l'Université de Lille 1
Janv. 2003-Mai 2004: Post-Doctorat à l'Université de Varsovie
Juin 2004-Aout 2004: Invité au CRM de Montréal
Sept. 2004-Aout 2005: ATER à l'Université de Grenoble
Sept. 2005-Aout 2006: ATER à l'Université de Toulon
Sept. 2006-Aout 2007: ATER à l'Université de Cergy-Pontoise

Diplomes:
Thèse de Doctorat soutenue le 12 Décembre 2002 à l'Université de Lille 1
Agrégation externe de Mathématiques 1998

Situation Actuelle:
Depuis Sept. 2007: Maître de Conférences à l'Université de Cergy-Pontoise

Publications:
1. L. Bruneau, C.-A. Pillet: "Thermal relaxation of a QED cavity", A paraitre dans J. Stat. Phys.
2. L. Bruneau, A. Joye, M. Merkli: "Asymptotics of repeated interactions quantum systems." J. Funct. Anal. 239 (2006).
3. L. Bruneau: "Ground state for a quantum hamiltonian describing friction." Can. Journal of Math. 59 (2007).
4. L. Bruneau, J. Derezinski: "Bogoliubov Hamiltonians and one-parameter groups of Bogoliubov transformations." J. Math. Phys. 48 (2007).
5. L. Bruneau, A. Joye, M. Merkli: ''Random repeated interaction quantum systems.'' "Comm. Math. Phys. 284 (2008).".

Nombre total de publications (parues ou acceptées): 9.

Dragi KAREVSKI
né le 18/12/1970 à Longwy, France

Thèse de Doctorat : 1996 Thèse de Doctorat de l'Université Henri Poincaré, Nancy I en Physique et Chimie de la Matière et des Matériaux
Nomination : 1997 Maitre de conférences à l'Université Henri Poincaré
HDR : "Ising Quantum Chains", Soutenue le 14 décembre 2005

Travaux
5 publications significatives en rapport avec l'ANR

"Scaling behaviour of the relaxation in quantum chains"
Karevski D
Eur. Phys. J. B 27, 147-152, (2002)

"Scaling and front dynamics in Ising quantum chains"
Platini T and Karevski D
Eur. Phys. J. B 48, 225-231, (2005)

"Gradient critical phenomena in Ising quantum chain"
Platini T, Karevski D and Turban L
J. Phys. A: Math. Theor., 40, 1467-1479, (2007)

"Relaxation in the XX quantum chain"
Platini T and Karevski D
J. Phys. A: Math. Theor., 40, 1711-1726, (2007)

"Entanglement evolution after connecting finite to infinite quantum chains"
Eisler V., Karevski D., Platini T. and Peschel I.
J. Stat. Mech., P01023, (2008)

Nombre total de publications : 31

PAUTRAT, Yan
30 ans
E.N.S. Lyon 1995,
Doctorat 2003 à Grenoble,
Maître de Conférence à Orsay en 2004

Actuellement Maître de Conférence à l'Université d'Orsay.

C/ Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années

- Y. PAUTRAT, 2005, ''From Pauli matrices to quantum Itô formula'', Mathematical Physics, Analysis and Geometry 8.
- Y. PAUTRAT, 2004, ''Stochastic integral representations of second quantization operators'', Journal of Functional Analysis 208.
- S. ATTAL and Y. PAUTRAT, 2006, '' From repeated to continuous interactions '', Annales Henri Poincar´e, 7, p. 59-104.
- W. Aschbacher, V. Jaksi c , Y. PAUTRAT et C.-A. PILLET , 2006, ''Topics in nonequilibrium quantum statistical mechanics '', in Quantum Open Systems, vol.3, L.N.M. 1882.
- W. Aschbacher, V. Jaksi c , Y. PAUTRAT et C.-A. PILLET , 2007, '' Transport properties of ideal Fermi gases '', Journal of Mathematical Physics, to appear.

Nombre total de publications : 8

PELLEGRINI Clément

26 ans,
Magistère de l'E.N.S. Lyon en 2001,
Doctorant à Lyon 1 sous la direction de S. ATTAL
Thèse soutenue en juin 2008.
Actuellement post-doctorant à Durban (Afrique du Sud)

Liste de publications :

- C. Pellegrini, « Existence, uniqueness and approximation for stochastic Schrödinger équations : the diffusive case », The Annals of Probability, to appear
- C. Pellegrini, « Existence, uniqueness and approximation for stochastic Schrödinger équations : the Poisson case », submited
- C. Pellegrini, « Poisson and diffusion approximation of stochastic Schrödinger équations with control », submited
- C. Pellegrini, « Markov chains approximation of jump-diffusion stochastic models in quantum measurement theory », submited
- S. Attal, C. Pellegrini, « Return to equilibrium and heat baths for some quantum trajectories », preprint.

C. Pellegrini a obtenu le prix « Meilleure thèse de l'année 2008 en Mathématiques et interactions », décerné par la Fondation E.A.D.S.

<u>Thierry PLATINI</u>

Age: 26 ans

Post-Doctorant
Université Henri Poincaré
Nancy-1

Publications

- Entanglement evolution after connecting finite to infinte quantum chains, Eisler V., Karevski D., Platini T., Peschel I., J. Stat. Mech. (2008) 01023
- Work fluctuations in small quantum spin chains, Dorosz S., Platini T., Karevski D., Submitted to PRE (2007)
- Relaxation in the XX quantum chain, Platini T., Karevski D., J. Phys A: Math. Theor. 40 (2007) 1711-1726
- Out of equilibrium process in Ising quantum chains, Platini T., Karevski D., Journal of Physics: Conference Series 40 (2006) 93
- Scaling and front dynamics in Ising quantum chains, Platini T., Karevski D., European Physical Journal B 48 (2005) 225

Nombre total de publications: 6

JOYE, Alain,
43 ans

88: Ingénieur-Physicien en (Ecole Fédérale Polytechnique Lausanne),
92: Doctorat ès Sciences à l'EPF-Lausanne,
92-93: Chercheur CNRS Associé (Section 02), CPT-Marseille
93-97: Maître de Conférences (26ème section), Univ. de Toulon et CPT-Marseille
96: H.D.R. spécialité Mathématiques, Université de Toulon,
97- : Professeur (25ème Section) Université de Grenoble et Institut Fourier.
Actuellement Professeur 1ère classe à l'Université de Grenoble I

Liste des 5 publications les plus significatives des cinq dernières années

· S. ATTAL, A. JOYE, C.-A. PILLET, "Open Quantum Systems", Volume I: The Hamiltonian Approach, Volume II: The Markovian Approach, Volume III: Recent Developments, 2006, Springer Lecture Notes in Mathematics, 1880, 1881 & 1882.
· L. BRUNEAU, A. JOYE, M. Merkli: "Asymptotics of repeated interaction quantum systems ", 2006, Journal of Functional Analysis 239, p. 310-344 .
· S. ATTAL, A. JOYE, "Weak Coupling and Continuous Limits for Repeated Quantum Interactions", 2007, Journal of Statistical Physics, 126, p. 1241-1283.
· S. ATTAL, A. JOYE, "The Langevin Equation for a Quantum Heat Bath", 2007, Journal of Functional Analysis, 247, p. 253-288.
· A. JOYE, "General Adiabatic Evolution with a Gap Condition ", 2007, Communications in Mathematical Physics, 275, p. 139-162.

Nombre de Publications:
43 publications (Revues avec Comité de lecture)
9 publications (Comptes rendus de conférences avec Comité de lecture)
2 prépublications, 4 codirection d’ouvrage

Claude-Alain PILLET

Parcours professionnel
1997-2007 Université du Sud Toulon-Var, Professeur des Universités, 25ème section
1992-1997 Université de Genève, Maître d'Enseignement et de Recherche
1990-1992 University of Toronto, Assistant Professor
1987-1990 Université de Genève, Maître Assistant
1986-1987 CNRS, CPT-Marseille, Chercheur Associé (poste rose)
1982-1986 Ecole Polytechnique Fédérale, Zürich (ETH), Assistant
1981-1982 Ecole Polytechnique Fédérale, Zürich (ETH), Assistant Auxillaire

<u>5 publications importantes dans le domaine du projet</u>
1. V. Jaksic et C.-A. Pillet: Non-equilibrium steady states of finite quantum systems coupled to thermal reservoirs. Commun. Math. Phys. 226, 131 (2002).
2. J. Derezinski, V. Jaksic et C.-A. Pillet: Perturbation theory of W*-dynamics, Liouvilleans and KMS-states. Rev. Math. Phys. 15, 447 (2003).
3. V. Jaksic, Y. Ogata et C.-A. Pillet: The Green-Kubo formula and the Onsager reciprocity relations in quantum statistical mechanics. Commun. Math.. Phys. 265, 721 (2006).
4. V. Jaksic, Y. Ogata et C.-A. Pillet: The Green-Kubo formula for the spin-fermion system. Commun. Math. Phys. 268, 369 (2006).
5. W. Aschbacher, V. Jaksic, Y. Pautrat et C.-A. Pillet: Transport properties of quasi-free fermions. J. Math. Phys. 48, 032101 (2007).

Divers
- 39 publications dans des revues ou actes de congrès avec comité de lecture.
- Codirection d'ouvrages: 3 volumes des Lecture Notes in Mathematics (1880-1882) avec S. Attal et A.Joye.
- Membre du comité éditorial des Annales Henri Poincaré et du Journal of Statistical Physics.

Jean-Marie BARBAROUX
Né le 5 juillet 1969 à Hyères,
Parcours scientifique:
Mars 2005 - Septembre 2005: Délégation CNRS (section 02), Centre de Physique Th\'eorique Luminy (Marseille).
Mars 2004 - Septembre 2004: Délégation CNRS (section 01), laboratoire Jean Leray, université de Nantes.
Février 2002 - Aujourd'hui: Maî tre de conférences à l'USTV (Toulon), membre du Centre de Physique Théorique de Luminy,
Septembre 1998 - Janvier 2002: Maître de conférences à l'université de Nantes.

Publications
20 publications dans des revues internationales avec comité de lecture.
3 publications dans des actes de congrès avec comité de lecture.

Publications en rapport avec la thématique
W. Aschbacher, J.-M. Barbaroux : Exponential spatial decay of spin-spin correlations in translation invariant quasi-free states, J. Math. Phys. 48 (2007).
W. Aschbacher, J.-M. Barbaroux: Out of equilibrium correlations in the XY chain, Lett. Math. Phys. 77(1), 11-20 (2006).

SPEHNER, Dominique,
35 ans
Doctorat en 2000, à Toulouse,
Maître de Conférence à Grenoble en 2005

Actuellement Maître de Conférences à l'Université de Grenoble I

Liste des 5 publications (ou brevets) les plus significatives des cinq dernières années
A. Faggionato, H. Schulz-Baldes, D. SPEHNER, (2006), ''Mott law as lower bound for a random walk in a random environment '', Communications in Mathematical Physics , 263, p. 21-64.
D. SPEHNER, M. Orszag, 2003, ''Cavity QED: a quantum trajectory point of view'', Laser Physics, 13, p. 634-643
D. SPEHNER, 2003, ''Spectral form factor of hyperbolic systems: leading off-diagonal approximation, Journal of Physics A: Math. Gen., 36, p. 7269-7290
D. SPEHNER, M. Orszag, 2002, Temperature-enhanced squeezing in cavity QED, Journal of Optics~B: Quantum Semiclass. Opt., 4, p. 326-335
D. SPEHNER, M. Orszag, 2002, Quantum jump dynamics in cavity QED, Journal of Mathematical Physics 43, p. 3511-3537

VARGAS, Rodrigo,
29 ans

Juill. 2002: Licenciatura, Universidad de Chile,
Juin 2004: Master of Science, Mathematics, NY University
Sept. 2005: DEA, Jussieu (avec E. Blanchard)
Sept. 2005: Inscription en thèse à l'Institut Fourier, (dir. A. Joye) sur le sujet: « Interactions quantiques répétées et états stationnaires hors équilibre en mécanique statistique quantique. »

Situation actuelle: Doctorant à l'Institut Fourier, Université de Grenoble I, sous la direction de A. Joye.

Publications: « Repeated interaction quantum systems: van Hove limit and asymptotic states », Journal of Statistical Physics, Vol. 133, Numb. 3, (2008), p. 491-511..

BENSAAD, Rym, 24 ans.
Doctorante à l'Université de Toulon-Var, sous la direction de Claude-Alain PILLET.
Thèmes de recherches : Etude mathematique du transport dans les systemes quantiques ouverts.

VOGELSBERGER Sylvain, 25 ans

Juin 2004 : Licence 3 de Mathématiques, Université Joseph Fourier, Grenoble.

Juin 2005 : Licence 3 et Magistère de Physique, même université.

Juin 2006 : Master 1 et Magistère de Physique, même université,

année universitaire passée à Montréal (échange d'étudiants).

Juin 2007 : Master 1 de Mathématiques, Université Joseph Fourier, Grenoble.

Septembre 2008 : Master 2 « Sciences de la Matière », Ecole Normale Supérieure et université de Lyon 1 (stage à l'Institut Fourier, Grenoble, dir. D. Spehner).

Depuis octobre 2008 : Doctorant à l'Institut Fourier, Université Joseph Fourier. Thèse co-dirigée par A. Joye et D. Spehner sur le sujet :
« *Dynamique des systèmes quantiques couplés à des bains thermiques : décohérence, production d'entropie et perte d'intrication* ».

7.3. IMPLICATION DES PERSONNES DANS D'AUTRES CONTRATS / INVOLVEMENT OF PROJECT PARTICIPANTS TO OTHER GRANTS, CONTRACTS, ETC ...