Department of Mathematics

: *A diffusion model for rarefied gas flows in a curved channel*

: (in collaboration with P. Degond, L. Mieussens, S. Takata, and H. Yoshida)

A rarefied gas flow in a two-dimensional curved channel, driven by a pressure gradient imposed in the gas and/or by a temperature gradient imposed along the channel walls, is investigated on the basis of kinetic theorye2and/5mi(pressen)-7.ag temp3 is presented. In this algorithm, the atoms in the deposited film and the substrate atoms are handled differently. The equations for the elastic displacement of atoms in the film are extended to a rectangular region by the use of fictitious atoms and a connectivity matrix, allowing the application of standard multigrid ideas. Except for the top layer, the atoms in the substrate are completely removed and replaced by equivalent forces which can be efficiently evaluated using a fast Fourier transform. This formulation has been implemented in both two and three dimensions using V-cycles. It is found that the number of V-cycles needed to reach a certain level of accuracy is essentially independent of the system size. Numerical tests show that, for large domains, the multigrid-Fourier method is approximately 6 to 10 times faster than conjugate gradient based methods.

*Stochastic Weighted Particle Method for a Two Phase Vapour Flow*

: (in collaboration with K. Aoki, and W. Wagner)

In the first part of the talk we introduce the Boltzmann equation

[illegible]

[redacted]

[illegible]

...e second part of the talk, we present in numerics. Then, in th...

[illegible]

...[2], see [3] for detailed description. introduced in...

...method to the numerical solution of the ... We apply thi...

...gap between one dimensional steady state flow of a vapour in a g...

...(see [4]) ...

...nal noncondensable gas is present. ...tion

...e application of the DSMC to this problem is difficult if the Th...

...ount of noncondensable gas tends to zero with the Knudsen nu...

...obtained by applying number $Kn$. Our first numerical results

[illegible]

## References


[1] G. A. Bird. *Molecular Gas Dynamics and the Direct Simulation of Gas Flows*. Clarendon Press, Oxford, 1994.

[2] S. Rjasanow and W. Wagner. A Stochastic Weighted Particle ...

: *The Multiconfiguration time dependent Hartree Fock equations*

: This talk is a report on ongoing work with Isabelle Catto, Norbert Mauser and Saber Trabelsi.

The object of the Multiconfiguration time dependent Hartree [illegible]
[illegible] Fock equations [illegible] MCTDHF [illegible]
[illegible] an Ansatz to compute the evolution of $N$ quantum [illegible]
[illegible] wave function [illegible] for $N$ fixed but large enough. This Ansatz for [illegible]
[illegible] The ansatz is a finite sum of time dependent Slater determ[illegible]
[illegible] structure (fibration) which then involve a rather rich mathematica[illegible]
[illegible]uantum chemistry. [illegible] follows the intuition provided by the q[illegible]

: *Propagation of smoothness for the Boltzmann kernel without angular cutoff and applications*

We present in this talk works done in collaboration with Clement Mouhot; and with Giulia Furioli and Elide Terraneo.

It has been proven in the 90s that smoothness is created immediately when one deals with the spatially homogeneous Boltzmann equation without angular cutoff.

Many results in this direction have then been obtained in the last ten years, but this concept (of appearance of smoothness) does not seem in the end to be well adapted to treat a certain number of issues (among which, the question of stability/uniqueness, and the question of Gevrey type smoothness).

The more traditional search for propagation of smoothness (which is also relevant for the Boltzmann equation with angular cutoff) leads indeed to new applications in the following directions :

- Stability and Uniqueness for solutions of the spatially homogeneous Boltzmann equation with (non cutoff) hard potentials
- Propagation of Gevrey smoothness for the spatially homogeneous Boltzmann equation with (non cutoff) Maxwellian molecules

We discuss the relationship between these new results and older works on the same subject by Seiji Ukai and Nicolas Fournier.

: *Generalization of Mawell type models for the dissipative Boltzmann equation*

: *Kinetic models for economy*

: *Kinetic problems in reactive gas mixtures*

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We consider a four component mixture of species $A^i$, $i = 1, \dots, 4$, colliding among themselves and undergoing the reversible reaction $A^1 + A^2 \rightleftharpoons A^3 + A^4$, that may be described at the kinetic level, according to the model proposed in [Rossani, Spiga, Physica A, 1999], by the set of nonlinear integrodifferential Boltzmann-like equations

$$\frac{\partial f^i}{\partial t} + \mathbf{v} \cdot \frac{\partial f^i}{\partial \mathbf{x}} = Q^i[f] \qquad i = 1, \dots, 4 \qquad (1)$$

... The collision terms ... the four distribution functions ... provided by suitable integral operators, properly accounting for its mechanical and chemical parts ... of chemical bond in the chemical reaction, in addition to ... ing for exchange of mass and of energy ... umed for simplicity that particles are endowed with trans... the usual conservation laws. It is ass... ... component of the string of the stoichiometric coefficients ... tions are assumed to obey the microreversibility conditions, which imply existence ... ential cross sec... ... onal, yielding also collision equilibria as a seven–parameter family of Gaussian ... of an H–functi...

: *Quantum BGK models. Existence results in the slab*

: In kinetic theory, quantum effects can be taken into account by modified Boltzmann equations for Fermi-Dirac and Bose-Einstein particles. Similarly to the classical Boltzmann equation, BGK type equations can instead be investigated, involving the equilibrium state having the same mass, momentum and energy as the unknown distribution function. Existence of solutions to such BGK quantum kinetic equations are proven in a stationary frame in the slab.

: *Sharp bounds on 2m/r of general spherically symmetric static objects*

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In 1959 Buchdahl obtained the inequality $2M/R \leq 8/9$ under the assumptions that the energy density is non-increasing outwards and [illegible] dius of the boundary of the static body. The assumptions [illegible] area rad[illegible] In this work we [illegible] remove both of these assumptions and consider any static solution of the spherically symmetric Einstein equations for which the energy density $\rho \geq 0$, and the radial- and tangential pressures $p \geq 0$ and $p_T$, satisfy $p + 2p_T \leq \Omega\rho$, $\Omega > 0$, and we show that

$$\sup \frac{2m(r)}{r} \leq \frac{(1+2\Omega)^2 - 1}{(1+2\Omega)^2},$$

where $m$ is the quasi-local mass, so that in particular $M = m(R)$. We also show that the inequality is sharp. Note that when $\Omega = 1$ the original bound by Buchdahl is recovered. The assumptions on the matter model are very general and in particular any model with [illegible] satisfies the $p \geq 0$ which satisfies the dominant energy condition [illegible] hypotheses with $\Omega = 3$.

: *On mode coupling in the Benard problem*

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