Simulations of high-velocity impacts on porous targets: a successful confrontation with laboratory experiments M. Jutzi[1,2], W. Benz[1] and P. Michel[2], [1]University of Bern, Physikalisches Institut, Sidlerstrasse 5, CH-3012 Bern, Switzerland, mjutzi@space.unibe.ch [2]Cote d'Azur Observatory, University of Nice-Sophia Antipolis, UMR 6202 Cassiopee/CNRS, B.P. 4229, 06304 Nice Cedex 4, France

Introduction: The different populations of small bodies of our Solar System are believed to be composed, at least partially, of objects with a high degree of micro-scale porosity. The fragmentation of such porous objects requires a different model than that used for non porous bodies, or bodies containing macroporosity only. Recently, such a porosity model has been developed and introduced successfully in a 3D smooth particle hydrodynamics (SPH) code [1]. Here we present simulations of high-velocity impact experiments on porous targets whose main material properties have been measured. We show that using these measured properties, our numerical model is able to reproduce the outcome of the experiments under different impact conditions [2].

Method: Our numerical technique is based on the Lagrangian Smooth Particle Hydrodynamic (SPH) method. The standard gas dynamics SPH approach was extended [3] to include an elastic-perfectly plastic material description and a model of brittle failure based on the one of Grady and Kipp (1980) [4].

Our porosity model [1] is based on the so-called $P - alpha$ model [5]. The model provides a description of microscopic porosity with pore sizes beneath the spatial resolution of our numerical scheme and which is homogeneous and isotropic on scales above the resolution limit.

Results: We performed simulations of four impact experiments differing with each other by the velocity (2 to 4 km/s) and material of the projectile. The targets consist of pumice with an initial porosity of ~70%. Using our new SPH impact code including a porosity model, we are able to reproduce the experiments with a fixed set of material parameters. Fig. 1 for instance shows the size distribution obtained by both the simulation and the experiment for one shot. In Fig. 2, an image of the experiment taken at a fixed instant after the impact is compared to a snapshot of the simulation taken at the same time. This comparison indicates that velocities of the fragments are at least in the same range in the experiment and the simulation.

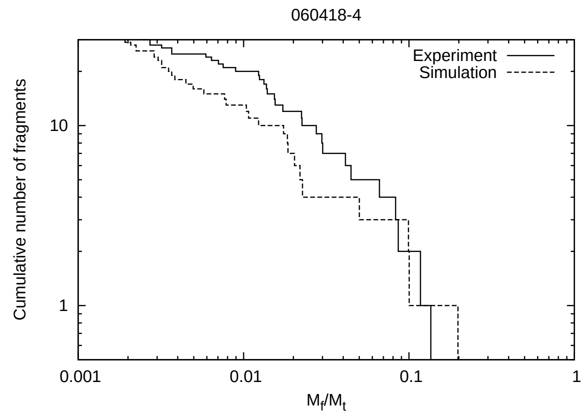

Figure 1: Cumulative mass distribution of fragments.

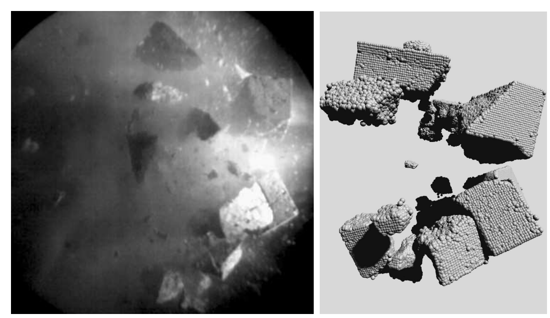

Figure 2: Fragments at the time t = 8 ms. Left: experiment, right: simulation.

Discussion and Outlook: A large fraction of small bodies of our Solar System are likely to be porous at micro-scales. Thanks to the satisfying validation of our model, we can start addressing problems related to the Solar System. In particular, the formation of C-type asteroid families from the disruption of a porous parent body and collisions in the Kuiper Belt are two processes than can now be investigated for the first time with our model, as we did in our study of the formation of S-type asteroid families, using our model of (non porous) brittle failure (e.g. [6].[7]). We also plan to investigate the catastrophic disruption criteria Q^*_D for porous bodies.

This work is supported by the Swiss National Science Foundation (M.J. & W.B.) and the French Programme National de Planetologie (P.M.).

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