TABLE TENNIS BALL AVALANCHE EXPERIMENTS

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ABSTRACT

Table tennis ball avalanche (TTBA) experiments were carried out on an inclined chute to study the dynamics and the structures of snow avalanches. The chute is 20 m long and 1 m wide; its inclination is 30 degrees. Ten thousand balls were released from the top of the chute. Measurements with video showed that the velocity of the head reached 8 m/s and was always larger than that of the tail, and accordingly the length of the TTBAs increased with time. The internal structure of the TTBAs could be divided into two layers; the lower layer was dense and in the upper layer, balls jumped vigorously and their number density was low.

INTRODUCTION

The knowledge on the structure and behavior of snow avalanches are fundamental to the understanding of their dynamics. However, natural snow avalanche data obtained so far are still insufficient.

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Recently, some laboratory experiments for snow avalanche dynamics have been done from the viewpoint of multiphase flow or granular flow (e.g. Maeno et al. (1985), Lang et al. (1989), Nishimura (1990), Nishimura et al. (1993)).

In the present study, avalanche experiments with table tennis balls were conducted on an inclined chute. This paper describes an outline of the experiments and gives some preliminary results.

EXPERIMENTAL SET–UP

Experiments were carried out on the chute of the Shinjo branch of Snow and Ice Studies, NIED, Japan. Figure 1 shows a schematic diagram of the chute. The chute is 27 m long and 1.0 m wide; its inclination is 30 degrees. The lower part of the chute is curved. The bed surface and the walls of the chute were made of glass plates and wood, respectively. Transparent windows were set on the wall to observe the flow behavior. Details of the chute construction are described by Nakamura et al. (1987).

Table tennis balls with 37.7 mm in diameter and 2.48 g in weight were used in the experiments. Colored balls with the same size and weight were mixed for the ease of observation. The maximum number of balls used in the experiment was ten thousand. Table tennis balls were stored in a container at the top of the chute and released simultaneously.

Several video cameras were used to record the flow behavior. In addition, high speed video system taking 200 frames per second was set up at a wall window to observe the motion of balls in detail.

PRELIMINARY RESULTS

Figure 2 shows a sequence of the general view of the experiment. Released table tennis balls flew down on the bottom surface forming an "avalanche". Figure 3 shows the positions and the velocities of the head and the tail as a function of time. The head velocity increased with time and reached 8.0 m/s at the end of the chute. Throughout an experiment, the tail velocity was roughly constant (4.5 m/s), which was almost equal to the terminal velocity of an isolated ball falling along the chute. The head velocity was larger than the tail velocity; accordingly, the length of the avalanches increased with time.

Figure 4 is the front view of the TTBA experiment. It is observed that table tennis balls collide actively each other and some balls jump up to significant height above the body of avalanche.

Side views of the TTBA are shown in Figures 5(a, b, c). A clear head was formed and a few balls were jumped out of the head (Figure 5(a)). In the body, a steady flow was formed (Figure 5(b)). The body could be divided into two layers at a height of about 0.1 m. In the upper layer, the number density was small and balls jumped vigorously. In the lower layer, number density was large; the direction of the ball motion was almost parallel to the chute and the change of relative particle positions was not obvious. The thickness of the avalanches decreased gradually from the body toward the tail (Figure 5(c)).

SUMMARY

Since TTBAs demonstrate some basic feature of snow avalanches, studies on their dynamics must contribute to the clarification of the dynamical behavior of natural snow avalanches. More detailed analysis and experiments under different conditions are in progress.

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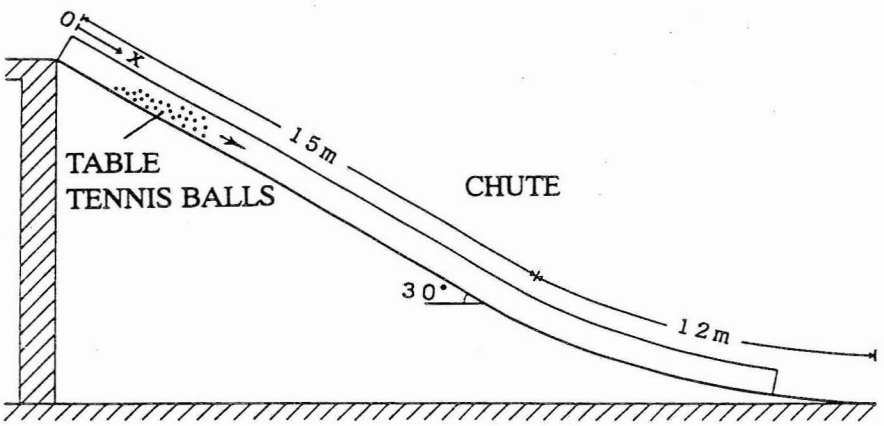

Figure 1. Schematic diagram of the experimental chute.

Figure 2. Sequence of general view of a table tennis ball avalanche experiment.

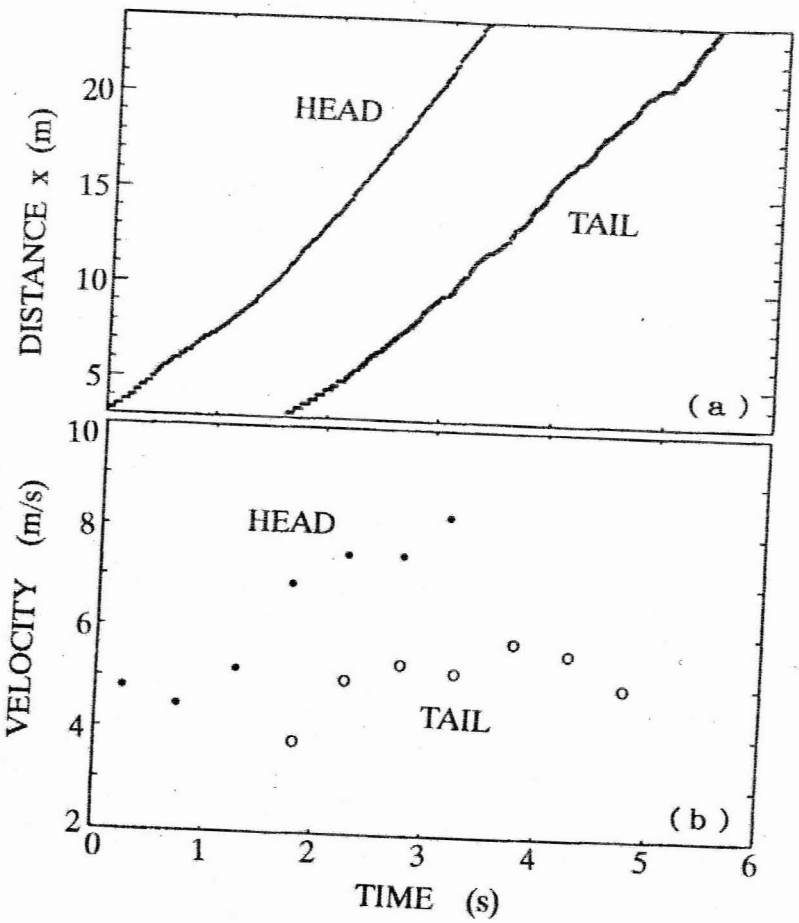

Figure 3. Positions (a) and velocities (b) of the head and the tail as a function of time. Distance x is measured from the top of the chute.

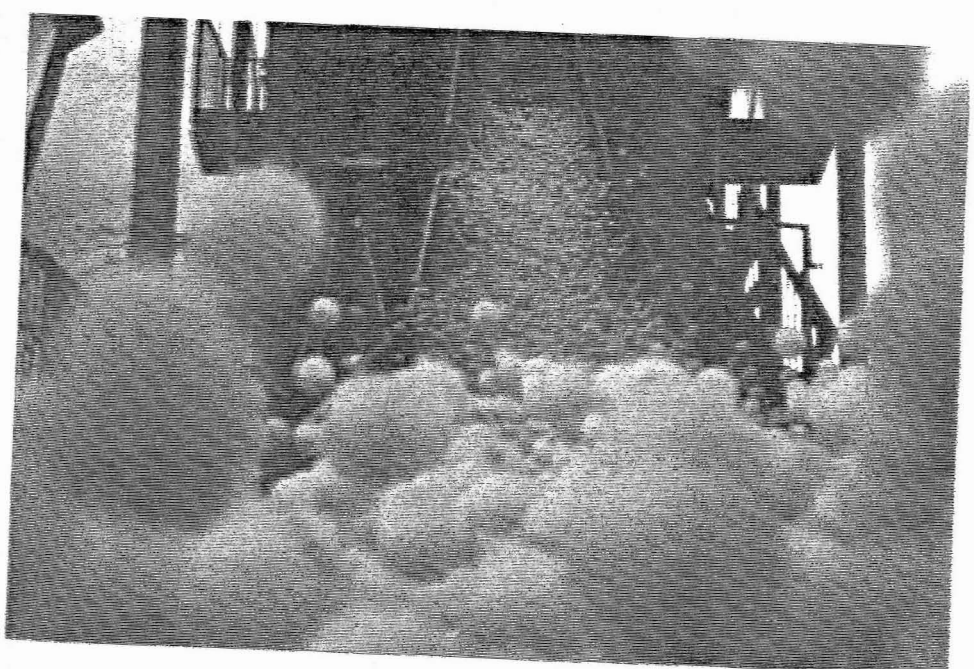

Figure 4. Front view of a table tennis ball avalanche experiment.

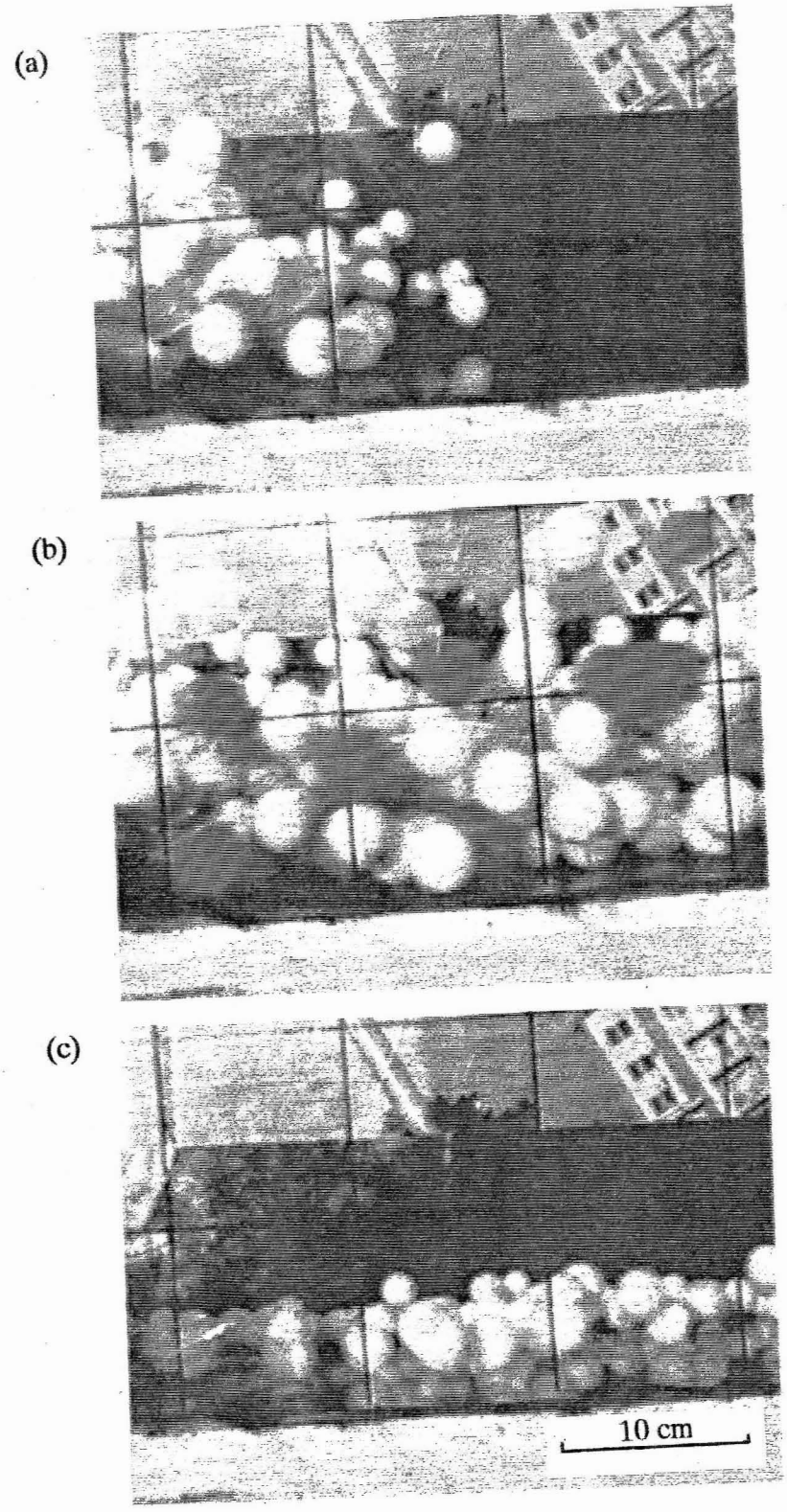

Figure 5. Side views of a table tennis ball avalanche: (a) head, (b) body, (c) tail. The direction of motion is from left to right.