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## Demonstration of a slow inelastic collision

F. Herrmann

*Institut für Didaktik der Physik der Universität Karlsruhe, Kaiserstr. 12, 7500 Karlsruhe 1, West Germany*

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To demonstrate the transmission of linear momentum from one body to another one readily carries out collision experiments. The word collision suggests a quick process. Indeed, the usual collision experiments consist of a quick exchange of momentum between two bodies, say two gliders on an air track.<sup>1</sup> The advantage of this quickness is that the attention of the student is drawn to the states before and after the collision and not to the collision process itself. The student is incited to make the momentum balance of the process.

Nevertheless, at another stage of the mechanics curriculum it will be important to show that the momentum transmission is a process which lasts a finite time. For an elastic collision this can be shown by carrying out the collision by means of a weak spring or with two magnets, one on each glider, with the like poles near to each other. It is the purpose of this paper to describe a simple arrangement which allows an inelastic collision to be extended over a time of several seconds.

At one of two gliders (glider 2 in Fig. 1) a pulley of about 3 cm in diameter is fixed (Fig. 2). The rotation of the pulley with its axis is purposely restrained by friction. The friction is caused by a little spring on the axis of the pulley and can be regulated by tightening the spring or loosening it. A thread of sewing cotton of about 3-m length is wound on the pulley and the free end of the thread is attached to the other glider (glider 1 in Fig. 1). Both gliders are placed a small distance apart on the air track. Now, glider 1 is given a push to the right. The thread unrolls from the pulley, but at the same time pulls at glider 2 via the axis of the pulley. The momentum of glider 1 begins to decrease and that of glider 2 to increase. This process comes to an end after

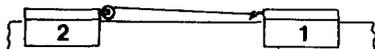


Fig. 1. When glider 1 is given positive momentum the thread unrolls and slowly transfers momentum to glider 2.

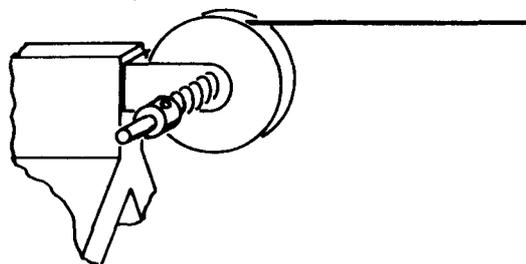


Fig. 2. The rotation of the pulley and the axis to which it is attached, is restrained by friction.

some seconds, when both gliders move with the same velocity. It is nice to see both gliders move with a constant distance of 1–2 m (according to the strength of the friction) over the remaining length of the air track.

We use this experiment in the physics lecture to demonstrate the establishment of collision equilibrium.<sup>2</sup> Momentum is an extensive quantity and the velocity is the conjugate intensive variable.<sup>3</sup> From glider 1 to glider 2 a momentum current is flowing<sup>4</sup> until the value of the intensive variable on both subsystems (the two gliders) is the same. The state which is now attained is a state of equilibrium: The energy of the gliders has its minimum value and the entropy produced in the process is maximum.<sup>5</sup> The establishment of rotational equilibrium (transmission of angular momentum until the angular velocities of the subsystems are equal) has been described in a recent article.<sup>6</sup>

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