32. Galileo's mast

(Chapter of the book Apparent Relativity (pdf))

32.1 Galileo refutation of Aristotelian motion

In his *Dialogue concerning the two chief world systems*, Galileo refutes the Aristotelian conception of motion and proposes a new explanation that, implicitly, assumes the Principle of Inertia [139, p. 106-275]. Among others, the discussion between the Aristotelian Simplicio and the Galilean Salviati is exemplified with the thought experiment of the stone dropped from the top of the mast of a ship while the ship moves with respect to the dock at a uniform velocity v [139, p. 126-127]. Contrarily to the hegemonic Aristotelian opinion, Galileo defended the stone hits at the base of the mast.

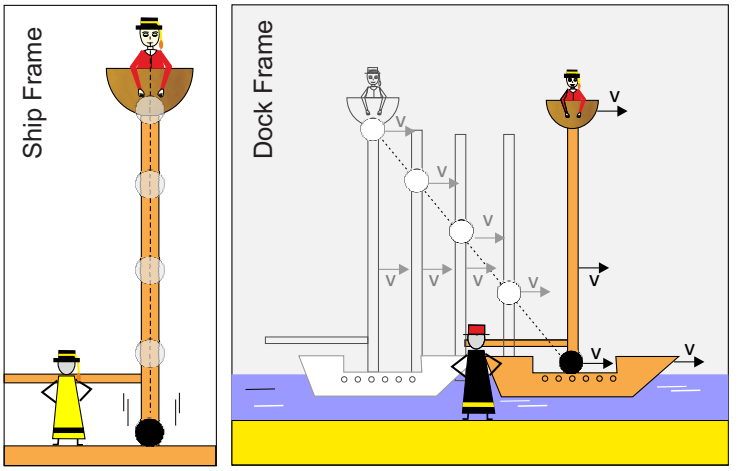

Figure 32.1 – Galileo's mast from the perspective of the ship (left) and from the perspective of the dock (right). For all observers, be them at rest in the ship or in relative motion with respect to the ship, the stone follows a trajectory parallel to the mast of the ship.

Galileo was right. And now we can give the reason for which the stone hits at the base of the mast: the (inductive) Principle of Inertia (just of Galileo-Newton): before being dropped the stone and any object in the ship moves with respect to the dock with the same uniform velocity v; once dropped, and while falling, the stone maintains that velocity v relative to the dock because no force other than

gravity acts on it. So, as it moves down it will continue to move in the horizontal direction with the same velocity v as the boat and its crew. For this reason the observers in the dock observe the stone follows an inclined (slightly parabolic) trajectory while the crew observe the stone follows a vertical trajectory (Figure 32.1).

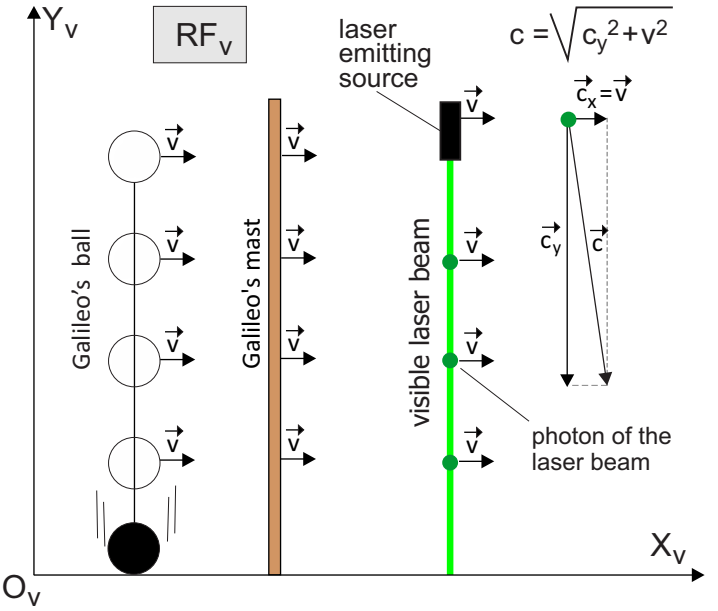

Figure 32.2 – Galileo's mast an the visible laser beam.

32.2 A universal observable

There is a little detail in the above argument of Galileo's mast that is rarely taking into account:

> That for all observers, whatever the relative velocity (direction and modulus) at which Galileo's mast is observed, the stone is always seen to fall in line with the mast, i.e. IT FALLS ALONG A MOVING PATH PARALLEL TO THE MAST.

This is a universal observable that we will now make more evident by replacing the stone by a visible (for instance green) laser beam vertically emitted from the the top of Galileo's vertical mast to the horizontal deck of the ship. This laser beam will be observed by all observers, including those in the ship, as a visible and vertical (Theorem 2, page 290) laser beam parallel to Galileo's mast (Figure 32.2).

All observers outside the ship will see a vertical moving beam of green light parallel to the vertical mast of the ship, moving parallel to the vertical mast with the same speed as the mast, and the rest of the boat. So, for each of these exterior observers, while each photon of the laser beam moves from its emitting source to the ship's deck, it also moves with the same relative velocity as the ship, whatsoever be this relative velocity. These observers will have to conclude each

photon inherits the relative velocity of its source as a component of its own velocity vector, and maintains it while traveling from its source to its target. As we will see in the next section, this universal observable poses two serious problems to SR.

32.3 Absolute or relative? Real or apparent?

Assume (only for a moment!) that absolute motion with respect to an absolute frame RF_a (for instance the frame of discrete physical space units introduced in Part V) were possible. All objects of any other reference frame RF_v moving with respect to RF_a at a velocity v will move at the same velocity v respect to RF_a, including the photons created and emitted in RF_v (Chapter 31).

In these conditions, and under the assumption of the constancy of the speed of light, it would be impossible for the observers in RF_v to detect and measure its absolute motion with respect to RF_a with the only aid of the objects of RF_v, including its proper photons (for the same reason it is impossible to determine the speed of a train inside the train and with the only aid of the objects inside the train).

So, and thanks to preinertia, all experiments a la Michelson-Morley would give negative results in the detection of absolute motion (if that were an absolute motion to detect), except maybe in the case discussed in Part IV. Obviously, being undetectable is not the same as being nonexistent. Chapters 33-34 introduce formally preinertia and the Law of Preinertia, and discuss on the undetectability of absolute motion.

Let now Galileo's mast and its parallel laser beam be observed from any number of reference frames, each with a different relative velocity with respect to the ship. From each of these frames, their corresponding observers will always observe a visible laser beam parallel to the mast of the ship, that moves parallel to the mast of the ship, with the same velocity as the mast of the ship (and the rest of the ship). If all these observers meet to discuss on their respective observations, they would have to consider the following two alternatives:

a) Each of their respective observations corresponds to an actual reality, as advocated by SR. In this case, each photon inherits from its source at the instant it is created as many velocity vectors as relative velocities at which it can, and could, be observed. An alternative that does not seem very realistic.

b) Their respective observations correspond to apparent realities, different perceptions of the same absolute reality which are consequences of their respective different velocities with respect to an absolute reference frame RF_a, which in turn causes them to move at different velocities relative to each other; relative velocities that are the only detectable velocities.

The problem of the second alternative is that the velocity of a physical object with respect to RF_a is not observable because of the Principle of Inertia and the universal inheritance of the velocity vector of the frame where the object is set in motion (Theorem 3, page 309). So, as just indicated, the only observable velocities

would be relative velocities. Except, maybe, the unique situation discussed in Chapter 41. The next chapter deals with this universal inheritance of motion, as well as with the impossibility of detecting absolute motion, the existence of which is, at present, anathema in current physics.