Delo E. Mook and Thomas Vargish are the authors of the book Inside Relativity, which was published in 1987. On page 69 they write about the principle of relativity.

...Newton realized that no law of physics known to him could distinguish inertial frames of reference–in other words, a law of the sort we have supposed that depends on relative speed v does not exist. This conclusion–the essence of Einstein's first postulate, or principle of relativity–remains as true as it did in Newton's day.

Banesh Hoffmann paraphrased the content of the postulated principle of relativity very neatly:

If we are in an unaccelerated vehicle, its motion has no effect on the way things happen inside it.

Identical experiments we perform inside any unaccelerated frames of reference will yield the same results; the detection of absolute (unaccerated) motion is ruled out. Notice that the statement refers to experiments inside the frames (for example, inside the car with the window shades pulled). An experiment involving a view of another reference frame (for example, by looking out the window at the adjacent car passing by) will of course detect relative motion (a ball tossed by someone in the next train moves along arcs while a ball you toss moves vertically). The person on the other train, performing the same internal experiments as you, will obtain physical laws identical to yours (she will see her ball move vertically; looking outside at your passing train, she will see your ball move in an arc).

Einstein states the principle of relativity as a postulate, albeit one that seems to be in accord with our experience of uniform motion. But he does not restrict his statement to experiments dealing with motion; he says that all laws of physics will be the same for unaccelerated observers. This statement must be a postulate because Einstein cannot prove its validity; he believes it because he thinks that this is the way the world must be, and no law of physics has yet been found to violate his assumption.

Several questions arise with regard to above quotation. Do the laws that describe the flow of heat through conduction and convection conform to the principle of relativity? Do identical experiments involving convective heat flow performed inside any type of unaccelerated frame of reference yield the same results? Do the experiments described in preceding quotation as occurring strictly on the inside of the frame of reference actually maintain this distinction with no exceptions?

If you were traveling on a train, you could stand in the aisle of a passenger car and toss a ball up and down along a vertical line. As the ball moved upward it would decelerate under the influence of the earth's gravity. As the ball fell down it would accelerate under the influence of the earth's gravity. The mass of the earth plays a crucial role in the behavior of the ball and it is not inside the frame of reference.

If you were inside a large cube with sides made of copper and if this large cube was raised 20 feet or perhaps more off the ground by 4 sturdy legs, the heat from a heat source located at the center of the cube would flow out from all the sides of the cube at an equal rate, provided that the experiment is performed on a day with thick cloud cover and no wind.

If we were to secure the cube to a railroad flatcar on a day with thick cloud cover and no wind and if we pushed the flatcar from behind with an electric engine so that it traveled along a straight line at 70 mph, when we turned on our heat source, the heat would no longer flow out from all the sides of the cube at an equal rate. The side of the copper cube that was facing forward would have the greatest heat loss of any side because cooler air would be rushing against that side with great force sweeping away heat from that side of the cube. The top, the bottom, the left and the right sides of the cube would have equal amounts of heat loss per side caused by the rushing air, but it would be less than the forward facing side. The side of the copper cube facing backwards would have the least amount of heat loss because it would be the side most protected from the effects of the cooler air rushing by.

It seems experiments performed entirely within the copper cube would give different results depending on whether or not the copper cube was at rest with respect to the earth or moving in an inertial manner. For instance, if we divided the copper cube in half so that the front section and back section formed two equal compartments, we could then place a heat source in the center of each compartment. If each heat source produced an equal amount of heat, then when the copper cube was at rest the temperature of each compartment would rise at the same rate, provided the effects of sunlight and wind are minimized. But, if the copper cube possessed an inertial motion, then the temperature of each compartment wouldn't rise at the same rate, the forward compartment would be cooler than the rear compartment.

By analyzing the results of such an experiment an observer in the cube could determine whether the cube was at rest relative to the earth or in inertial motion. Also the observer might determine his direction of motion and the magnitude of his motion.

Even on a day with ample sunshine and wind, an observer in the copper cube might be able to determine if the cube was at rest or in a state of inertial motion. The observer in the cube might be able to discern the heat signature of the sun as it moved across the sky. The observer might also be able to discern the cooling signature of the wind. Once these factors were known he could make determinations about the motion of the cube.

What would happen if the cube were somewhere very far out in space, situated somewhere in the space between the galaxies? Since the vacuum of space isn't completely empty, would the sparsely dispersed particles that constitute the vacuum have a similar effect as the earth's atmosphere on the cube?