

Question

Imagine you want to steer your bike or motorcycle through a left-hand corner. In which direction do you have to turn the handlebar?

Answer

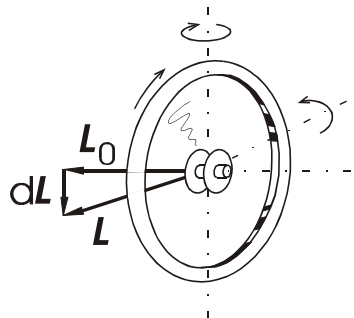
In a nutshell. You have to turn the handle bar in the opposite direction, i.e., you have to turn to the right.

Please don't do it yourself! Single track vehicles are dangerous. So please do not test what is going to happen if you push slightly the handle bar to the right whilst traveling along at a normal speed. I am going to tell you now. The vehicle tilts to the left.

Background. Two track vehicles can be steered by varying the direction of wheels. On single track vehicles, however, no transversal forces must be exerted. The centrifugal force would cause it to fall outward. Hence we must bank the bike inward so that this tendency is compensated by the machine's weight tending to make it fall inward.

Physics of single track vehicles steering. Steering of single track vehicles is a complex process. Let us restrict to the banking of a bike. This is the dominating effect unless the vehicle stops or moves very slowly.

The main aspect is the angular momentum of the front wheel. The Figure on the right shows qualitatively what is happening. If you try to turn the spinning front wheel to the right, you will find that the wheel tilts to the left. You may go and remove the front wheel from your bike, hold it upright in both hands, get a helping hand to spin it, and turn it as mentioned above.



Physical Description

Remember: The Angular momentum is represented by a vector. Its length stands for the absolute value of the angular momentum. Its direction expresses the position of the rotation axis. The orientation follows the "corkscrew-rule".

Initially the wheel has the angular momentum L_0 . Now a moment of force T is exerted via the handle bar to the wheel during the time dt . This gives an additional angular momentum for the wheel $dL = dt \cdot T$ and on the whole the front wheel owns the total angular momentum $L = L_0 + dL$. Notice that the direction of dL like those of T is downwards, because the handle bar is turned to the right and the corkscrew faces the bottom.

As we expected, the position of the new angular momentum vector L indicates that the front wheel is tilted to the left.