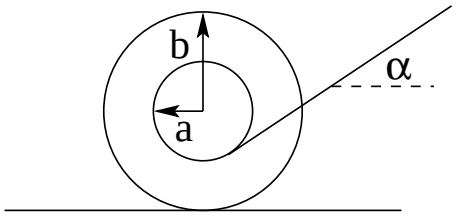
[mex142] Reel of thread II: dynamics

A reel of thread whose spindle and rim have radii a and b, respectively, rests on a horizontal table. The weight of the reel is mg and the moment of inertia for rotations about its axis is I. The loose end of the thread passes under the spindle and leads off at an angle α above the horizontal as shown. The static frictional force between the reel and the table during rolling motion is $f \leq \mu_S N$, where N is the normal force and μ_S is a constant. Consider the range $0 \leq \alpha \leq \pi$ of angles.
(a) For a given tension not too strong to make the reel roll without slipping, find the angular acceleration $\dot{\omega}$, the frictional force f, and the normal force N.
(b) For the three cases $\alpha = 0, \pi/2, \pi$ find the direction (clockwise or counterclockwise) of the angular acceleration $\dot{\omega}$ and the direction (left or right) of the frictional force f.
(c) For the three cases $\alpha = 0, \pi/2, \pi$ find the maximum possible value of $|\dot{\omega}|$ for rolling without slipping.



Solution: