ASTR430 Handout 3: Non-gravitational Forces

Force	Size	Formula	Quantities	Direction	Application
Solar Wind	$< \mu$m	—	—	in or out	nebula clearing; corpuscular drag
Radiation Pressure	$\sim \mu$m	$F = \frac{LAQ}{4\pi c r^2}$	L = bolometric luminosity A = particle x-sect area Q = correction factor ~ 1 r = orbital radius	radially out	dust clearing; solar sails
Poynting-Robertson Drag	$\sim$ cm	$t_{\rm PR} \sim \frac{7 \times 10^6 a \rho r^2}{Q}$ yr	a = particle radius (m) ρ = part. density (kg/m^3) r = orbital radius (AU)	spirals in	large dust must be replenished
Yarkovsky Effect	$\sim$ m–km	$F = \frac{8}{3}\pi a^2 \frac{\sigma T^4}{c} \frac{\Delta T}{T} \cos\psi$	T = temperature ΔT = temp. difference ψ = obliquity	in or out	asteroid family spreading; meteorite delivery
Gas Drag	$\lesssim$ km	$F_D = \begin{cases} -\frac{C_D A \rho_g v^2}{2}, & a > \lambda \\ -A\rho v v_0, & a < \lambda \end{cases}$	C_D = drag coef. ~ 1 ρ_g = gas density v = particle speed λ = mean free path of gas v_0 = thermal gas speed	spirals in	nebular disk interactions (damp e, i); atmospheric drag