Light collection by objectives

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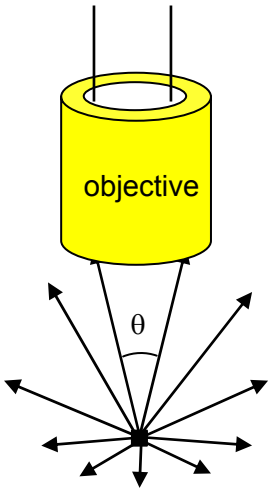
We all use objectives in microscopy. The magnification is easy enough to figure out. But what is this strange number printed on the side of the objective: n.a.? This stands for 'numerical aperture', a measure of how much light the objective can collect, as defined by the 'cone' of light subtended by the objective aperture from the sample plane. The larger the numerical aperture, the more light can be collected from a point source radiating in all directions (e.g. from a fluorescent sample).

To calculate amount of isotropically-generated light collected by a lens of given numerical aperture:



Numerical aperture = na = sin (θ/2)
If light is emitted over a sphere i.e. isotropically from a point source
% of light collected = -1/2 (cos (θ/2) -1)

Examples:
if na = 0.5
sin (θ/2) = 0.5; θ/2 = 30 degrees, θ = 60 degrees
% of light collected = 6.7 %

To collect 5% of available light θ = 51.7 degrees and n.a. = 0.44
To collect 10% of available light θ = 73.7 degrees and n.a. = 0.6
To collect 20% of available light θ = 106.26 degrees and n.a. = 0.8

This is why good lenses are expensive.....