Super-resolution or super resolved fluorescence microscopy, as indicated in the Chemistry Nobel Prize 2014 awarded to Eric Betzig, Stefan W. Hell and William Moerner, includes those microscopy techniques that increase the resolving ability of a light microscope well beyond the classical limits dictated by the diffraction barrier [1]. Since the end of the 19th century Ernst Abbe (1873) and Lord Rayleigh (1896) clarified the reasons such a limit that makes/made impossible to resolve two elements of a structure when they are closer to each other than approximately $\frac{1}{2}\lambda$ in the lateral (x,y) plane and $\approx \lambda$ along the axial direction (z).

So far, several methodologies have been developed over the past several years for super-resolution fluorescence microscopy including saturated structured-illumination microscopy (SSIM), stimulated emission depletion microscopy (STED), photoactivated localization microscopy (PALM), fluorescence photoactivation localization microscopy (FPALM), and stochastic optical reconstruction microscopy (STORM). Such a development had some important “gregarios/sparring partners” in computational optical sectioning microscopy, confocal and two-photon laser scanning microscopy, scanning near-field optical microscopy, green fluorescent proteins advent and information communication approaches. The list is not complete. Resolution improvements have been made with confocal and multiphoton microscopy, as well with approaches like 4PI and I5M. However, in general, approaches dealing with resolution improvements remained confined by Abbe’s and Rayleigh’s prescriptions. We can also see the limit as set by concepts of information theory. I like to mention the Toraldo di Francia approach related to super resolution [2] as starting point, and to go across all those attempts and improvements predicted and implemented within the scientific community focused on optical microscopy [3]. What is revolutionary today, in my view, is the fact that there is theoretically no limit for capturing details by means of an optical microscope and that, at the very same time, there is the possibility of tuning the spatial resolution according to the scientific question posed.

In the style of Johannes Faber referred to the Galileo Galilei’s occhialino [4], one can modify the sentence “microscopium nominare libuit” in “nanoscopium nominare libuit” for the super-resolution fluorescence microscope that has become a nanoscope.

This lecture is dedicated to the memory of Osamu Nakamura (1962-2005) and Mats Gustafsson (1960-2011) that passed away too early, that I met for the first time in a FOM meeting years ago. I am indebted with the Nanoscopy group at Istituto Italiano di Tecnologia.