Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Vision below threshold: why it can be beneficial to waste photons
MORITZ KREYSING, Department of Physics, LMU Munich, Germany, KRISTIAN FRANZE, Department of Physiology, Development and Neuroscience, Cambridge University, UK, MIKE FRANCKE, ANDREAS REICHENBACH, Paul Flechsig Institute, University of Leipzig, Germany, JOCHEN GUCK, Biotechnology Center, TU Dresden, Germany — Vision at low light intensities relies on photoreceptors being able to detect individual photons. As an accepted rule, the light sensitive portions of vertebrate rods and cones, namely outer segments, increase in volume the darker the animals' habitat gets in order to enhance the probability to capture incident photons. Consequently, the biggest outer segments are found in fish living in the deep sea. A peculiar exception to this rule are the eyes of some deep sea fish, as well as fish living in highly turbid rivers. In their retinas relatively short outer segments are bundled into spatially isolated groups, clearly not meant to maximize the probability of photon absorption. Based on a detailed morphological and optical study of multilayer light-collectors surrounding these segments [1], we argue that under extreme conditions in which quantum noise, i.e. the rate of spontaneous photo-pigment activation, becomes comparable to the rate of photon arrival, visual sensitivity cannot be achieved by large outer segments anymore. Instead the retinal focusing of light on very small receptors is the only way to lower the visual threshold further, or to see at near IR wavelengths, even though this means partial photon loss. References: 1. M.Kreysing et al., Science 336, no. 6089 (2012)

Moritz Kreysing
Department of Physics, LMU Munich, Germany

Date submitted: 29 Nov 2012 Electronic form version 1.4