INDIRECT IMAGING OF PROXIMA b AND EARTH-LIKE PLANETS. Svetlana V. Berdyugina[1,2] and Jeff R. Kuhn[2], [1]Kiepenheuer Institut für Sonnenphysik (KIS), Freiburg, Germany, sveta@leibniz-kis.de, [2]Institute for Astronomy / Maui, University of Hawaii, USA, kuhn@ifa.hawaii.edu.

Introduction: Seeing oceans, continents, life colonies, hurricanes, and other surface and weather features on exoplanets may allow us to detect and characterize life outside the solar system. The recently discovered Proxima b planet may be Earth-like as it resides within the stellar habitable zone allowing for liquid water on its surface. However, even the largest planned telescopes won't be able to resolve its surface features directly.

Method: Here, we employ an inversion technique to indirectly image exoplanet surfaces and atmospheres, i.e. obtain their albedo maps. This technique was previously used for recovering brightness and magnetic field distribution on unresolved stellar surfaces [1,2]. To resolve albedo features in both latitude and longitude, observations of spatially integrated reflected light variations over the course of their orbital and axial rotation are needed. We call this techniques Rotational Exo-Planet Imaging (REPI) [3]. We test our algorithm using NASA Earth Observations (NEO) measurements of the Earth albedo by simulating observed reflected light variations and carrying out inversions for a wide range of geometrical parameters of the planet and its orbit (Fig. 1). We also study effects of various noise sources and demonstrate that planet rotational axis orientation can be retreaved even from low signal-to-noise data..

Results: We show how albedo maps of Proxima b can be successfully reconstructed for tidally locked, resonance, and unlocked axial and orbital rotation. We estimate that a 20m aperture interferometric telescope [4,5] can achieve high contrast and collect enough information in the Proxima b reflected light curve to resolve continent-size structures in both longitudinal and latitudinal structures. Such albedo maps obtained in different wavelength passbands can provide "photographic" views of Proxima b and other planets. Using polarimetry enhances the contrast of such photographs and can help detecting large-scale, land-based colonies of photosynthetic organisms [6].

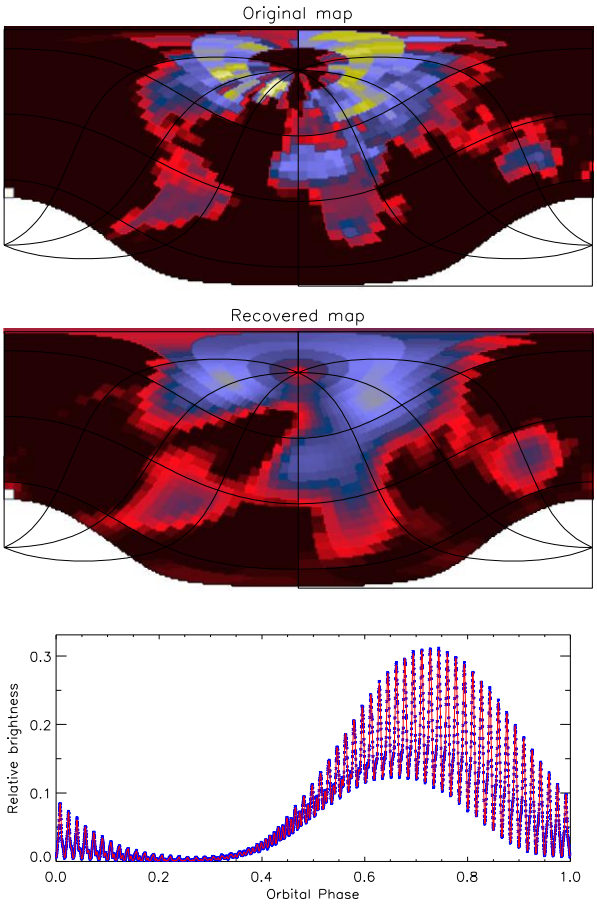

Figure 1: Original (top) and recovered albedo maps (middle) and light curves (bottom) for one of test models. The original map is based on NEO measured Earth albedo used to simulate the ”observed” light curve (blue symbols). The solid red-line light curve is the best fit model corresponding to the recovered map. Error bars of the simulated data are smaller than the symbol size. The recovered albedo map reproduces well continent outlines and relative average albedo.

References::

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