

## DES External Collaborator Application

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Project Title: HST Infrared Photometry of DES SN Ia at  $z=0.4$

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External Collaborator: Robert Kirshner (Harvard University)

Working Group: SN

### Executive Summary

This document outlines a proposal from Masao Sako and Bob Nichol (co-chairs of the DES SN Working Group) for Robert Kirshner to become an External Collaborator (EC) on a project to study the intrinsic colors of SN Ia and the properties of dust in their host galaxies. The EC has an approved Cycle-20 Large Program on HST called RAISIN (an anagram of "SN IA in the IR") to obtain target-of-opportunity WFC3 observations of 25 SN Ia candidates at  $z\sim 0.4$ . This proposal requests access to small sample of selected DES SN candidates to be discovered in Year 1 (2013-2014) for follow up with HST. DES and HST photometry will be exchanged and shared by DES and the EC. The requested EC status is for 1 year.

### Scientific Motivations and Goals

The early work from CTIO, the work of the Carnegie SN Project, and work at the CfA demonstrates that SN Ia are better standard candles in the near infrared (yJHK) than in optical bands. Corrections for extinction by dust are also 4 times smaller than in the rest frame B. Kirshner, together with his students Kaisey Mandel (now a postdoc at the CfA) and Andy Friedman (now a postdoc at MIT) and collaborators have developed powerful Bayesian tools for combining rest frame IR and optical data to provide more precise and more accurate distances to supernovae in the nearby Hubble flow. Since the current state-of-the-art for supernova cosmology is limited by systematic errors, not sample size, the superior performance of SN Ia in the IR is a strong motivation for realizing this advantage in a cosmological sample.

To this end, Kirshner is the PI for a 100-orbit HST program, GO-13046 dubbed RAISIN (an anagram for SN Ia in the IR, and an allusion to those raisins in rising dough used so often to illustrate cosmic expansion.) This program allows for non-disruptive ToO observations of 25 SN Ia in order to observe the rest frame y and J bands with the WFC3 on HST. Modeling shows that good behavior of SN Ia in the IR implies that we can expect a result for the constraints on  $w$  from this sample that is quite comparable to the current state-of-the-art for statistical uncertainty ( $\sim 0.07$ ) and a smaller systematic uncertainty.

Kirshner requests EC status to receive candidate RAISIN targets from DES. He will use already scheduled time at the MMT, Magellan, and Keck in the coming months to follow up DES

candidates that are plausible candidates for the RAISIN program (estimated redshift in the zone from  $z=0.3$  to  $0.5$ ). Previous RAISIN targets have come from PanSTARRS, but Kirshner wishes to establish that DES will serve this purpose both for this September and October, and as a proof-of-concept for a possible extension of RAISIN after PanSTARRS1 observations end in December. Spectra of DES targets can be followed up with HST through the October dark run by approval (already granted) by STScI. Observations of DES targets by Kirshner and his collaborators will continue through the entire DES season. The spectra will be shared with the DES Supernova Working Group, and the photometric data in the near-IR will be combined with DES data to provide powerful new measurements of SN Ia distances for DES discoveries. These distances will help construct more certain constraints on the dark energy properties using DES supernovae.

### **Details of the Agreement**

- 1) DES will provide the EC with coordinates of both confirmed and unconfirmed  $z\sim 0.4$  SN Ia candidates, finder charts, and other information necessary to trigger spectroscopic and HST imaging follow up.
- 2) Unconfirmed candidates may be observed spectroscopically by the EC using his approved time on Magellan, MMT, and Keck. The EC will provide redshifts and spectra of all DES targets observed.
- 3) DES will provide griz photometry and the EC will provide HST photometry of SN candidates followed by the program.
- 4) The EC agrees to abide by the Membership and Publication Policies of DES and the Principles for the Organization and Management of DES Science Projects.

### **References:**

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