

External Collaborator MOU – Assaf Horesh

External Collaborator

An external collaborator is an individual who is not a ZTF Member or Associate, but who wishes to engage in long-term mutually beneficial collaboration with ZTF members on specific, prescribed ZTF science analyses.

If such a collaboration can benefit multiple groups and science programs within ZTF, and the ZTF collaboration is amenable to such a setup, individual MoU's will cover each project with a different senior ZTF member from each Key Project as a Point Of Contact (POU) for each MoU.

The collaboration MOUs are one year at a time and expected to be renewed annually, based on mutual satisfaction.

Project Collaborators Template:

(1) Proposed contribution to a ZTF Key Project

The focus of the proposed collaboration is radio follow-up observations of core-collapse supernovae. The primary goal is to use radio observations to probe the mass-loss history of the progenitor star and trace the highest velocity ejecta. Horesh has been part of PTF and iPTF as member and co-led the radio follow-up campaigns of these projects. Horesh has expertise in radio observations of different types of transients and has been granted observing time in the past on multiple radio facilities (e.g., VLA, CARMA, ALMA, VLBA, EVN). During his PTF and iPTF tenure Horesh also gained experience in optical spectroscopy and photometry.

Horesh has purchased observing time on the AMI radio telescope for studying transients and as a result Horesh is now co-leading the transient science on AMI. The AMI observing time guarantees a minimum of 600 hours per year for the next few years (and essentially covers the full duration of the ZTF project). The primary value of the AMI time is that it can serve as a filter/motivator for sensitive VLA observations. In essence, AMI gives a strong leg up for highly competitive VLA proposals. Separately, Horesh has already been granted VLA and ALMA time to study flash spectroscopy supernovae from ZTF (in collaboration with Kulkarni, Gal-Yam and Sollerman).

A VLA proposal to conduct a systematic study of a large sample (primarily volume limited) of core-collapse SNe is pending review (also in collaboration with ZTF senior members).

This document notes explicitly an approved VLA program focused on radio studies of spectroscopically identified Ic-BL, Ibn SNe (regardless of the optical survey) and engine driven supernovae (PI: Corsi). I am also aware of a pending proposal for potential relativistic explosion SNe as a part of Ho's thesis project.

(2) List all personnel Assaf Horesh (and his students/postdoc).

In regards to a thesis project, there is currently only one active master student that is working on supernovae and is expected to perform radio observations and statistically study the radio properties of supernovae as part of his thesis. This student may continue to do his Phd on the same subject. Another student may join the group to partly work on ZTF radio supernova in 2019. In addition, a postdoc will be joining the group on Nov 1, 2018. The group also now includes 4 undergrad students who are expected to participate in the research in terms of helping with triggering radio observation and initial data analysis. In summary, my group may include students on all levels (undergrad research students, MSc, PhD) and also postdocs.

(3) Observing Resources

Please note that in addition to AMI I will be bring in LCO resources (via Israel's LCO program)

AMI telescope – Minimum of 600 hours a year (enough for observing 20-30 transients a years multiple times).

LCO – An average of 50-60 hours per year

VLA – Approved program for 2018.

ALMA - Approved program for 2018

(4) Points of contact (POC) in the Partnership

The following have, to date, expressed interest in radio observations: Kulkarni, Ofek, Gal-Yam, Sollerman

The chief point of contact will be Gal-Yam (with SRK as backup)

(5) Proposed publications

The expected publications are as follows: Individual papers on flash spectroscopy supernovae. A sample paper (once a large enough sample has been collected) of flash spectroscopy SNe. These papers will discuss both the very early and also the later time radio emission and therefore interaction in these type of SNe.

Individual papers on exquisite nearby supernovae (such as PTF11eon/SN2011dh and PTF12gzk in the past).

In 2-3 years, a large sample paper on core-collapse supernovae.

Overall, in some cases the radio data will be incorporated in papers led by ZTF members and in some cases Horesh (or his students/postdocs) will lead the paper and having ZTF members as Co-Is (this will depend on the focus on the papers).

(6) Required access to ZTF data

Required access is the prompt alert of the SN candidate, including photometry and position and spectroscopy information if available. This is required in order to assess whether the SN is young, what type is it, what is the distance to the SN. These properties are required in order to make a decision on whether to trigger the radio facilities (in particular AMI), and also to decide which program to trigger and how to set the observation strategy and follow-up plan. These decisions will be made in collaboration with the ZTF members. As additional information that is collected on the SN, this information may affect the observing plan for the radio observations. In summary, I expect to use alerts from the ZTF partnership (private) stream as part of this MoU.

- (7) **Data Rights and Benefits.** Include the following in the MOU: *In return for their specific contribution, the members of a Project Collaboration will be included in all papers that specifically rest on their contribution and, of course, given the specific arrangements within their MoU they will be able to lead papers based on their proposed program in a given ZTF Key Project. Given the large size of the ZTF Consortium, well-defined and specific Project Collaborations are strongly preferred.*