# Optical time domain whole sky survey and Transient/Monitoring science NCU's Pan-STARRS transient cross matching

Y. Urata[1], K.Y. Huang[2], M. F. Tsai[3], C.H. Tang[3], C.S. Shen[3], Y.J Lin[3] and Taiwan PS1TCS team

[1] Institute of Astronomy, National Central University, Chung-Li 32054, Taiwan
[2] Academia Sinica Institute of Astronomy and Astrophysics, Taipei 106, Taiwan
[3] Department of Computer Science and Information Engeering, National Central University, Chung-Li 32054, Taiwan
*E-mail(YU): urata@astro.ncu.edu.tw*

Abstract

Pan-STARRS(the Panoramic Survey Telescope And Rapid Response System) will be able to scan the visible sky to approximately 23rd magnitude in less than one week. This unique combination of sensitivity and field of view will open many new possibilities in time-domain astronomy and address a wide range of astrophysical problems in the Solar System, the Galaxy, and the Universe. NCU, Taiwan is one of the member of Pan-STARRS Science Consortium (PS1SC). We are working on (1)GRBs (both triggered and orphan events), (2)new type transients, and (3)cross matching of high energy transients detected by Swfit, Fermi, MAXI etc. The cross matching of MAXI and Pan-STARRS transient is one of the standard project of Pan-STARRS (PIs Y.Urata and K.Y. Huang). The main aspects of this cross-identification are (1)Supernova Shock-break out such as SN2008D/XRF090105, (2)Optical identification of X-ray flash.

Key words: workshop: proceedings — LaTeX2.09: style file — instructions

## 1. Pan-STARRS

Pan-STARRS(the Panoramic Survey Telescope And Rapid Response System) is an innovative wide-field imaging facility to carry out the most ambitious astronomical survey to date. The survey starts in March 2009 and this novel hardware has the potential to tackle an unusually rich set of astronomical problems, from an inventory of near-earth asteroids to the nature of cosmic dark energy. Above all, the cosmic variable science is one of the important issues together with ongoing great missions for monitoring and transients from gamma-ray to optical; gamma-ray (Fermi), X-ray (Swift, MAXI), and optical (Pan-STARRS). Since Pan-STARRS surveys the whole sky visible from Hawaii every 10∼20 days, it offers an unprecedented opportunity to discover and monitor those rare, explosive objects that challenge the limits of our understanding of astrophysics.

The most novel aspect of the Pan-STARRS is that it will search for SNe without any galaxy bias. Virtually all nearby SNe searches to date search the brightest, highest star-formation rate galaxies, which means high metallicity. Pan-STARRS offers the opportunity to search for "rare events", low metallicity explosions, and the faintest explosions, and the faintest explosions which are predicted to be related to black-hole formation. Some of these events will be discovered as a result of Pan-STARRS routine monitoring of the whole sky (3-Pi survey), while fainter ones will be searched for with directed deeper surveys (Medium Deep survey). sources.

## 2. Science targets

NCU, Taiwan is one of the member of Pan-STARRS Science Consortium (PS1SC). We are working on (1)GRBs (both triggered and orphan events), (2)new type transients, and (3)cross matching of high energy transients detected by Swfit, Fermi, MAXI etc. The cross matching of MAXI and Pan-STARRS transient is one of the standard project of Pan-STARRS (PIs Y.Urata and K.Y. Huang). The main targets of this cross-identification are (1)Supernova Shock-break out such as SN2008D/XRF090105, (2)Optical identification of X-ray flash.

(1)SNe with shock break out such as SN2008D and XRF060218; Prompt bursts of X-ray and/or ultraviolet (UV) emission have been theorized to accompany the break-out of the SN shock-wave through the stellar surface, but their short durations (just seconds to hours) and the lack of sensitive wide-field X-ray and UV searches have prevented their discovery until SN2008D. In the XRF060218 case, the prompt emission was reported as XRFs.

One of our advantage to pick up the real X-ray flash event is our new development of cross transient identification server for Pan-STARRS and MAXI. Therefore

This document is provided by JAXA.

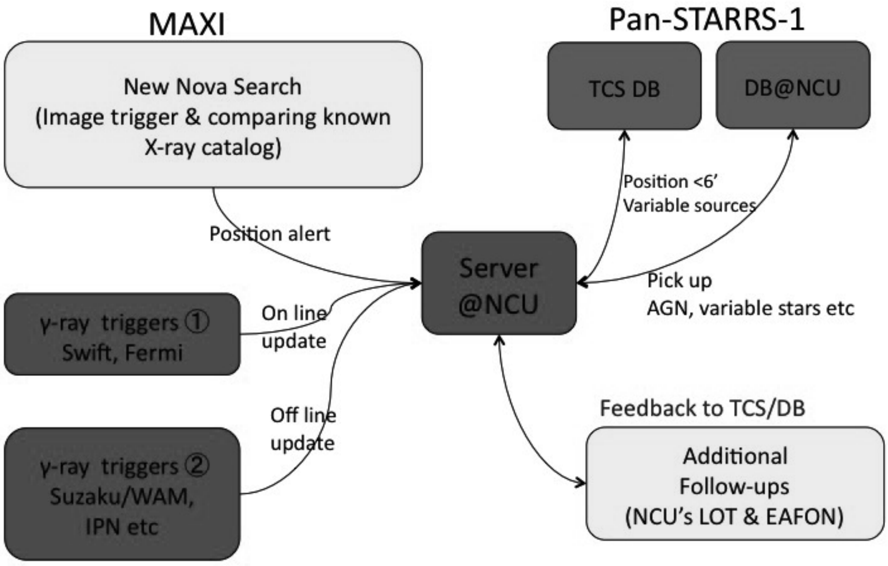


Fig. 1. Cross identification diagram. The cross identification of MAXI transient is one of the Pan-STARRS's standard project.

we can exclude MAXI's X-ray trigger made by transient AGNs and other variable sources. To exclude GRBs event, we/MAXI team will cross matching with gamma-ray trigger provided by Swift/BAT, Suzaku/WAM and so on.

Once we pick up suitable SNe shock break out event with optical counterpart, we will trigger spectroscopic follow-up to confirm the classification and to determine the redshift. This cross matching also allow us to perform optical spectroscopic monitoring from early stage. The temporal optical spectroscopic observations are essential to reveal these origin and describe feature very well. In the SN2008D case which has shock break out component, there is a clear spectral evolution from a mostly featureless continuum to broad absorption lines, and finally to strong absorption features with moderate width. in addition, the spectra reveal the emergence of strong He I features within a few days of the explosion. These results revealed the SN2008D is a He-rich SN Ibc, unlike GRB-SNe. These results imply the similarity between the shock break-out properties of the He-rich SN 2008D and the He-poor GRB-SN 2006aj, both suggestive of a dense stellar wind around a compact Wolf-Rayet progenitor.

(2)X-ray flashes (XRFs) are generally thought to be a sub-class of gamma-ray bursts (GRBs). The main difference between XRFs and GRBs is the energy of the emission; the peak energy, Epeak, of XRFs is distributed in the range from a few keV to 10∼20 keV, while that of GRBs is distributed from 20 keV to 20 MeV. Due to the lack of suitable X-ray instruments and optical counterpart identifications/monitoring after HETE-2 era, the origin of XRFs is still unclear. MAXI will provide XRFs alerts with significant number of other X-ray transient triggers such as transient AGN. The transient cross-matching will pick up suitable XRF candidates. With responsing to the suitable alerts, the optical counter part identification and its dense monitoring are essential to reveal origin/nature of XRFs.

The multi-color optical and infrared light curve studies give us off-axis angle once we detect re-brightening phase, or rejection of off-axis model when we observe the achromatic light curve break. The spectroscopic observation will allow us to measure the distance of the XRF which is essential to estimate the energetic of the explosion. These optical and infrared combination analysis will open the door to perform correlation studies such as Amati relation and Ghirlanda relation. Amati et al (2002) found the empirical relation between the rest-frame spectral peak energy of prompt emission $E_{peak}^{src}$ and the isotropic-equivalent energy released during the prompt phase $E_{iso}$. Ghirlanda et al (2004) showed a tight empirical relation between the $E_{peak}^{src}$ and the collimation-corrected energy $E_\gamma$ based on monochromatic temporal break in optical/IR afterglow light curve (so-called jet break). The existence of these correlations could flag crucial properties of GRB physics which are not yet fully understood.

This document is provided by JAXA.