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SPECTROSCOPY OF TRANSIENTS WITH MISTRAL AT OHP

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Abstract. The many on-going sky surveys, on ground or space, reveal dozen of variables or transients per night which require a spectrum to be properly caracterised. This includes Novae and SNe (in particular, the Ic's associated with some GRBs), FBOT's, FRB's, etc...TDE's help to detect otherwise quite AGN's and CLQ's challenge the standard unified scheme of AGN's. The advent of the LSST/Rubin telescope and of the SVOM satellite will multiply such events and the brighter ones can be studied with Mistral at OHP.

Keywords: Supernovae, AGN, Quasars

1 Introduction

The many on-going sky surveys from ground (ZTF, Atlas, ASAS-SN, Pan-STARRS, YSE) or space (Swift, Gaia...) reveal dozen of variables or transients per night which need to be caracterised. While the long-term lightcurve can eventually allow classification for standard objects, like classical Ia SNe, to catch peculiarities and understand the physics behind the event requires spectroscopy, even before the maximum if possible. Among explosive events, this includes superluminous SNe (SLSN), whose energy source is still unknown, or Luminous Red Novae or other types of objects: in a diagram showing the peak luminosity versus the caracteristic timescale of the event, the full space is progressively filled in with new events (Fig.1), following efforts by the ZTF consortium at Palomar, or the PESSTO survey at ESO (Smartt et al. 2015), and recently at OHP with Mistral (Fig.2). GRB's are discussed elsewhere in this volume (Schneider et al.).

2 The variety of events

When the event is occuring close to the nucleus of the host galaxy, it is a-priori difficult to distinguish between a SLSN or a Tidal Disruption Event (TDE) or an occurrence in the nucleus itself, without a sequence of follow-up spectroscopy. Initially, the spectrum often just shows a featureless, blue continuum (which is also the case for a classical type II SN when the enveloppe is still optically thick), but then develops some lines: OII lines typical of a SLSN ; or H or He emission lines (or no lines at all) for TDE's, depending on its class. Particularly caracteristic of some TDE's is the early presence of a broad emission complex around 4640 Å, which is a mix of NIII and HeII excited by Bowen fluorescence, lines which progressively vanish with time. The TDE could eventually be identified later when the full lightcurve is available, but it is then to late to get the physical parameters.

Some other, new types of rapid transients have been identified in the last decade, but are not yet understood. Fast Blue Optical Transients (FBOTs) show a rapidly raising light-curve, followed by an as-fast decay, with timescales of a few days: the few spectra obtained so far show only a featureless continuum, whose temperature is however decreasing with time. They may be the initial phase of explosion of a massive star with an optically thick envelope, which then collapses directly to a blackhole. Fast Radio Bursts (FRB's), detected in radio waves, are now detected by dozens with the CHIME instrument: only few of them have been located so far within an identified host galaxy, but we have no details about their immediate environment; they could be due to bursts in a magnetar. After the first detection by gravitational waves of a neutron stars merger and its location in a nearby galaxy (GW170817, Abbott et al. (2017)), more such events are expected: some could even be detected in the optical without the signature of GW's, but none has been detected this way

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so far. When more precise GW locations become available in the future, all those objects will deserve a detailed spectroscopic follow-up to understand the on-going mechanisms and the production of r-process elements.

Now talking not about transients, but about variable objects, Active Galactic Nuclei (AGN's) or Quasars deserve a special mention. A number of cases of changing spectra, the so-called Changing Look Quasars (CLQ's), have been identified (under others by Gaia Alerts, whose angular resolution is essential, e.g. Huo et al. (2020)), where Broad Lines appear with an increase of the central brightness, or disappear with dimming of the nucleus (e.g. MacLeod et al. (2016)). This is at odds with the standard model of AGN's, where the absence of broad lines (in Seyfert 2's) is thought to be due to obscuration of the central engine by the so-called torus lying on the line of sight. The timescale of such changes (from months to a few years) is not compatible with a change of orientation. Instead, it could be due to changes in obscuration towards, or in luminosity of, the central engine. In support of this idea is the recent detection of dormant AGN's which wake-up thanks to the fuel brought by a TDE: an example is AT2022cmc (Pasham et al. 2023) which reached an absolute magnitude of -25, typical of an AGN, but it was unknown before. The survey of variable galactic nuclei can thus reveal more AGN's, particularly those with intermediate mass black holes which are hard to detect otherwise, and nearly similtaneous observations in the optical (OHP) and the X-rays (SVOM) will be essential to understand them.

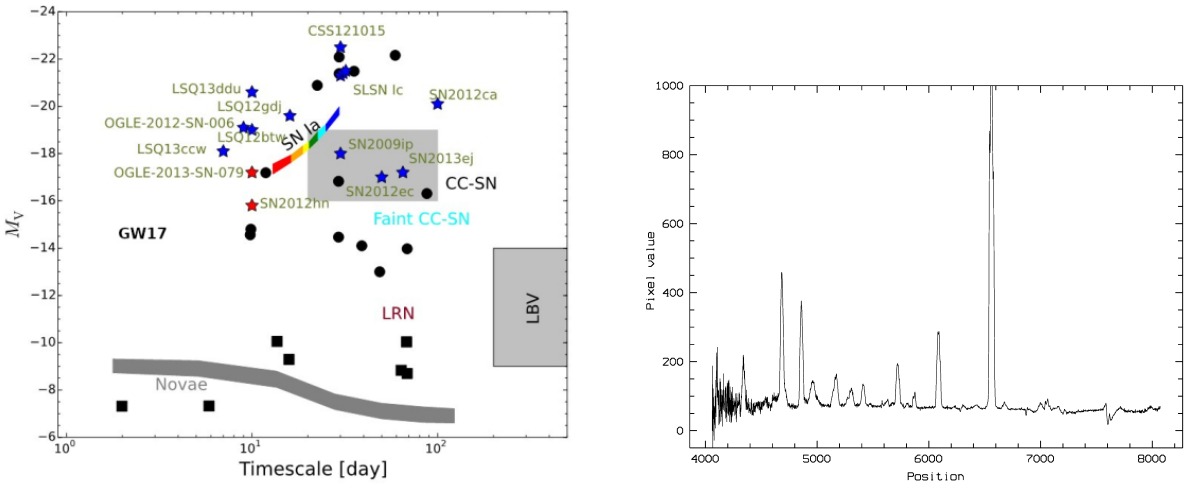

Fig. 1. Left: Some PESSTO results, after Smartt et al. (2015). **Right:** OHP spectrum of NovaCas 2021.

3 Conclusions

It is thus clear that rapid (within a few nights) spectroscopic follow-up of newly detected transients or variables is key to understand their physics. More important than just an initial classification is the obtention of a time-series of spectra which reveal the evolution of the object. To be able to do this, we need to lift the present limitation at OHP, which limits the number of ToO's and prevents from obtaining more than one ToO spectrum every three nights ! This will become particularly sensitive with the launch of SVOM early next year, which is expected to provide many transients of various nature. Or even more so when the next Galactic SN will be detected...

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