

SpS1-Silicate dust formation around AGB stars

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VISIR, the VLT Imager and Spectrograph for the Mid-Infrared is a multi-mode instrument, featuring also a high resolution Echelle spectrograph with a spectral resolving power $\frac{\nu}{\Delta\nu}$ of $\approx 30\,000$ or 10 km s^{-1} at $\nu \approx 30\,000\text{ GHz}$ ($\lambda \approx 10\ \mu\text{m}$). A limited long-slit mode as well as a general cross-dispersed mode are available. The Echelle grating is illuminated with a 200 mm diameter collimated beam. Cross-dispersion is achieved by a pair of grisms in the pre-slit optics. The entire frequency interval corresponding to the “ $10\ \mu\text{m}$ -window” from $22\,400$ to $39\,500\text{ GHz}$ is fully accessible, albeit sequentially. This interval contains a multitude of fundamental molecular rotational-vibrational bands such as SiO , OH^- , H_2O , NH_3 , CH_4 and many other hydrocarbonates. Since its commissioning in April 2004, VISIR has been plagued by artifacts introduced from its detector. The cross-dispersed mode is especially handicapped, as it is the most demanding mode for dynamic range of illumination. Now an ambitious upgrade with a pair of newly developed $1k^2$ As:Si detectors is underway, which will fully resurrect the spectroscopic mode. This will also increase the frequency interval accessible in one exposure by 240% while changing from critical to 3-pixel sampling. Even in the absence of extra spectral features this increase is quite valuable for absorption line spectroscopy, as the limiting factor in analysis often is the definition of the photospheric continuum.

While the typical width of molecular rotational-vibrational absorption lines in giant stars is more of the order of $3\text{--}5\text{ km s}^{-1}$ VISIR will still allow for spectroscopic studies of the molecular gas surrounding RGB and AGB stars. One obvious science project after recommissioning is to propose parallel observations with VISIR at $\nu \approx 37\,500\text{ GHz}$ ($\lambda \approx 8\ \mu\text{m}$) and with the CRIRES spectrograph at $\nu \approx 75\,000\text{ GHz}$ at three times higher resolution to measure simultaneously the SiO overtone and fundamental band, in combination with low resolution spectra, again with VISIR, sensitive to silicate dust. This could be combined with other high-resolution IR spectra to constrain the atmospheric structure even better. Even shocks, atomic hydrogen emission (*Brackett α* , $\nu = 74\,074\text{ GHz}$) is a proven diagnostic observed in Mira-stars, can be investigated.

Silicate dust is ubiquitous in the universe. It is found in planetary systems, circumstellar disks of stars in various stages of their evolution, in molecular clouds, or in tori of AGNs. It is a well established observational fact that AGB stars are surrounded by silicate dust, while undergoing sometimes even extreme mass loss (\dot{M} up to $10^{-3}M_{\odot}/\text{yr}$). Still, a detailed understanding of the process of dust formation, as well as the efficiency, is lacking. Thus the amount of dust produced by AGB stars, and consequently the relative importance of this source to produce a major constituent of the ISM, remains unclear. Synoptic observations of a sample of pulsating AGB stars will provide for a fundamentally new data set. Observing the dust and its parent molecule with many different transitions in combination with state-of-the-art models will allow for a new approach to settle the issue of silicate dust production.