Thesis Summary

In this thesis we studied the innermost regions of V838 Monocerotis (V838 Mon) using the most cutting edge interferometric instruments at the VLTI and CHARA facilities. We used a plethora of instruments at these observatories that spanned a wide range of wavelengths in the near to mid-infrared regimes. V838 Mon erupted in 2002 in a luminous red novae (LRN) event due to which its luminosity increased by many orders of magnitude. After the outburst the object cooled and eventually formed new dust in its surroundings. A stellar merger is thought to be the cause of the outburst. According to this hypothesis an 8 $M_\odot$ B-type star merged with a 0.3 $M_\odot$ young stellar object. The dusty environment of V838 Mon makes it an ideal candidate for near IR interferometric studies. In the literature we found only two studies that studied V838 Mon using the previous generation instruments at VLTI and PTI. We were therefore interested in using the more recent cutting edge instruments (MATISSE, GRAVITY, MIRC-X) to image the circumstellar environment of V838 Mon. Using these images we then aimed to construct radiative transfer models that could give us more insights into the eventual fate of V838 Mon, such as whether we can expect it to become a blue straggler. The thesis comprises of three first authored publications, the first two of which have been published in Astronomy and Astrophysics, while the third has been submitted for publication. In the first paper we analyse MATISSE observations at the VLTI using which we were able to infer the size and orientation of the dust in the LM bands. This was the first observational evidence of a such a feature in these bands. Also the orientation that we found seems to suggest that this structure is similar in terms of alignment to the other structures that had previously been observed in the N band and the mm/sub-mm regimes. However simply modelling the interferometric observables is not sufficient, which is why for a more robust analysis one needs to perform full imaging of the source. This is what we accomplished in the second paper. We had applied for observations at the VLTI with the MATISSE and GRAVITY instruments and were successful in obtaining telescope time. We had also applied for time at the CHARA array for their MIRC-X/MYSTIC instrument and were able to secure three nights of observations. With the resulting GRAVITY/VLTI and the MIRC-X/CHARA observations we now had enough data to perform high resolution image reconstruction. The images were made using state of the art imaging softwares and the angular resolutions that they probed were sub-milliarcsecond, thus making these images the first of their kind for V838 Mon. In the second paper our analysis shows that V838 Mon possesses bi-polar outflows in the HK bands, similar to what is seen in other merger objects. However this was the first observational information in the near infrared bands. Building upon this we then attempted to create a radiative transfer model that could explain the observed interferometric observations. Our efforts resulted in a third paper in which we used the radiative transfer code RADMC3D to construct a multi component model. Our modelling efforts revealed that the best dust model consists of an inclined torus, jets and and a small elliptical component that surrounds the star. We find that the jets are an integral component without which the observed closure phases cannot be explained. Furthermore the high dust temperatures also seem to suggest that these jets can potentially be transient. Future followup observations can help to answer whether the HK band structure is transient.