1 Summary and Conclusion

In this work, I simulated the evolution of supernova remnants using two distinct cooling modules, the Schure cooling module and the chemistry module, as described in Chapter 5.3. This was done in order to both explore the feasibility of simulating SNRs using these relatively simple cooling mechanisms as well as to compare the two modules with each other and to find out how their different properties may affect the simulation of the supernova remnants evolution.

For this purpose, I first researched about supernovae and supernova remnants in general (Chapters 1, 2 and 3). I explored the historical role of SNe in astronomic research, the different types of SNe and their evolution, in particular with the focus on the Sedov-Taylor phase and the Pressure-Driven-Shell phase. In chapter 4, I introduced a catalogue containing data about SNe in the Milky Way, which I used in conjunction with additional data from astronomic research (Chapter 7) to compare it with the output of the simulations.

hydrodynamic

Afterwards, I familiarized myself with the FLASH code used to execute the simulation. I explained what the FLASH code is, as well as the most important equations it is using for the simulations in Chapter 5. In 5.4, I also described my experimental setup, i.e. what parameters were adjusted to simulate the SNRs. Since my work required multiple simulations with different input parameters, I wrote several codes to automatically execute these simulations. I also wrote other codes to analyse the output data of these simulations. All of these codes and their usage are presented in chapter 5.4.

In Chapter 6, I show the typical evolution of a SNR on several examples by plotting the data from the simulations using Gnuplot. I then compare the simulations results that were produced with the two cooling modules with each other and show and discuss their differences. Especially the difference of mass distribution at the shock front before the shell collapse (Fig. 15) is a result worth future research. The Chapter 7 presents the comparison between the simulations and external data on SNRs in the Milky Way. Even though there has not been enough external data to make a conclusive evaluation, it can be concievable ~~at a later date, once~~ more ~~external~~ data ~~is~~ available.

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In conclusion, this work contributed to better understanding of how the two cooling modules work ~~take into account different properties~~ and affect the simulations of the SRN evolution. The results revealed that, as expected, the differences start to appear only at the

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later stage of SRN evolution, specifically around the transition between the Sedov-Taylor to the Pressure-Driven-Shell phase and afterwards. The analyses of the simulations have shown that the effect of the two modules manifests itself as a difference in how they treat the ~~high~~ increase of ~~mass~~ gas density preceding the shell collapse. While with the Schure cooling module, ~~adds the mass~~ the density increases further behind the shock front, with the chemistry cooling module, ~~adds the mass onto~~ the density increases at the shock front.

Both simulations also treat differently the final stages of the SRN evolution. Simulations with the chemistry cooling module, ~~simulates it~~ exhibit shell in a cone shape, while Simulations with the Schure cooling module, ~~simulates it~~ show shell in a form of two density spikes with an area of lower density in between. The difference manifests itself in size irregularities in the simulation with the Schure cooling module, because the detection code sometimes mistakes the first spike for the shock front and thus the actual size of the SNR.

It was not possible to make conclusions about which of the simulations using the two cooling modules better fits reality due to the lack of sufficient amount of representative data about the gas density around existing SRNs. However, since new data in astronomy accumulates very fast due to the advances in technology, it can be assumed that a continuation research might be possible at later time.