In chapter 5 we present optical spectroscopy in the range λλ3400–7900Å for a total of 52 planetary nebulae (PNe) in the Large Magellanic Cloud (LMC) and 18 in the Small Magellanic Cloud (SMC). This sample contains a large selection of objects of low luminosity, with measurements of line intensities down to ~10% of Hβ. Brighter objects have line intensities measured down to ~2% of Hβ. Reddening estimates from Balmer line ratios have been determined: unreddened and reddened line intensities are tabulated.

In chapter 6 we present echelle observations of 16 LMC PNe in the [O III] λ5007Å emission line, 10 of which are previously unobserved. An important property of these objects is that they lie far from the centre of the LMC and hence, their velocities provide strong constraints on the rotation of the LMC. These data have been used in conjunction with previously published data to redetermine the position angle of the kinematic line of nodes, Θ_0, and the systemic Galactocentric velocity, V_0, of the LMC. After analysis of our data, combined with data available in the literature, we confirm the previous values derived from PNe, where Θ_0~170° and V_0~40kms^{-1}. The LMC is confirmed to consist of a single disk, and not a dual disk structure as originally proposed by Freeman, Illingworth and Oemler.

In chapter 7, we examine the effects of stellar effective temperature, and stellar and nebular metallicities, on the emission line fluxes used in the planetary nebular cosmic distance scale determinations. An absolute calibration of this distance scale is made by determining the metallicity-corrected, cut-off in the luminosity function of PNe. The distance modulus to the LMC is derived by fitting shell He burning PN nucleus evolutionary tracks (presented in chapter 3) to the observations. Distance modulii, relative to the LMC, are also derived for the SMC, Galactic Bulge, M31, and the Virgo cluster, after correcting the absolute PN nuclei luminosities for both stellar age and metallicity effects, and using the observed luminosity function cut-offs for these systems. In all the cases where Cepheid distances are known, a –0.14 mag zero-point offset is found with respect to the PN distance scale. It is concluded that the principle source of uncertainty in the PN distance scale is the intrinsic upper luminosity cut-off of the PN nuclei which, in turn, is critically dependent upon the stellar age (and therefore, mass) distribution, and the treatment of mass loss in the stellar evolutionary models.

A SEARCH FOR HIGH-ENERGY GAMMA-RAYS FROM SUPERNOVA SN1987A

Liam Edwin Waldron

Department of Physics, University College, University of New South Wales, Australian Defence Force Academy, Canberra ACT 2600

April 1992

The Australian Defence Force Academy (ADFA) balloon-borne gamma-ray astronomy telescope was flown successfully from Alice Springs Australia twice during 1987 and 1988 (flights 87–2–19 and 88–1–5) with the aim of measuring the gamma-ray flux, in the energy range 50 to 500 *MeV*, from Supernova SN1987A in the Large Magellanic Cloud. The two flights corresponded to day 55 and day 407 respectively of remnant evolution. The instrument was complemented by a hard X-ray proportional counter, designed and constructed by the Istituto di Astofisica Spaziale, CNR, Frascati Italy, and sensitive to the 10 to 250 *keV* energy range.

In this thesis, an account is given of the physical processes responsible for the production of gamma-rays in astrophysical environments and their relation to supernovae and cosmic-rays. A description is then given of the main features of the gamma-ray telescope and its principle of operation, the most important part of the telescope being a spark-chamber used to determine the direction of arrival of incident gamma-rays. Data obtained during each flight was recorded as spark-chamber tracks on photographic film. A detailed account of the methods of subsequent data reduction and analysis, as carried out by the author, are given. The principal results of this work were that 3-σ upper limits to the gamma-ray flux from Supernova SN1987A of 2.2×10^{-5} *photons* $cm^{-2}s^{-1}$ and 3.4×10^{-5} *photons* cm^{-2} s^{-1} were obtained for days 55 and 407 of remnant evolution respectively, these limits being somewhat lower than previously reported in the literature from a preliminary analysis of the data.

The above two upper limits are consistent with Supernova SN1987A being an atypical Type-II supernova. That is, the progenitor was a blue, rather than a red, supergiant. The limits are compared with theoretical predictions related to current models of gamma-ray emission from young Type-II supernovae.

AN ULTRA-HIGH PRESSURE PROPORTIONAL COUNTER FOR HARD X-RAY ASTRONOMY

Zongnan Ye

Department of Physics, University College, University of New South Wales, Australian Defence Force Academy Canberra ACT 2600

November 1992

This thesis describes the successful development of ultra-high pressure proportional counters for balloon-borne hard X-ray astronomy. The proportional counters were filled with argon/xenon at pressures up to ~30 *atm*. The properties of proportional counters filled at such pressures have been studied by the author in the laboratory. The spatial response of these counters to X-rays and charged particles, and the energy response to X-rays up to 1 *MeV* have been analysed. Gas gain measurements using the charge collection technique and analysis of the subsequent data show that simple extrapolation from low pressures cannot explain the observed behaviour (e.g. the mobility of positive ions and quenching efficiency) of these counters at high pressures.

A hard X-ray telescope consisting of 32 such proportional counters filled at ultra-high pressures is being constructed, details of which are described. The sensitivity of this telescope for both continuum and narrow-line spectra is superb compared to contemporary balloon-and satellite-borne hard X-ray detectors. Together with an imaging phoswich Anger camera, it is scheduled for launch from Alice Springs in November 1994.

An anticoincidence system for an X-ray detector, consisting of a combined passive and active shield, has been designed and constructed by the author, and has been flown on a balloon. The active shield, made of a plastic scintillator, has resulted in an additional reduction of 25% in the background registered at balloon altitudes.

https://doi.org/10.1017/S1323358000027442 Published online by Cambridge University Press