= Type Ib and Ic supernovae =

Types Ib and Ic supernovae are categories of stellar explosions that are caused by the core collapse of massive stars . These stars have shed (or been stripped of) their outer envelope of hydrogen , and , when compared to the spectrum of Type Ia supernovae , they lack the absorption line of silicon . Compared to Type Ib , Type Ic supernovae are hypothesized to have lost more of their initial envelope , including most of their helium . The two types are usually referred to as stripped core @-@ collapse supernovae .

= = Spectra = =

When a supernova is observed , it can be categorized in the Minkowski ? Zwicky supernova classification scheme based upon the absorption lines that appear in its spectrum . A supernova is first categorized as either a Type I or Type II , then sub @-@ categorized based on more specific traits . Supernovae belonging to the general category Type I lack hydrogen lines in their spectra ; in contrast to Type II supernovae which do display lines of hydrogen . The Type I category is sub @-@ divided into Type Ia , Type Ib and Type Ic supernovae .

Type Ib / Ic supernovae are distinguished from Type Ia by the lack of an absorption line of singly ionized silicon at a wavelength of 635 @.@ 5 nanometres . As Type Ib / Ic supernovae age , they also display lines from elements such as oxygen , calcium and magnesium . In contrast , Type Ia spectra become dominated by lines of iron . Type Ic supernovae are distinguished from Type Ib in that the former also lack lines of helium at 587 @.@ 6 nm .

= = Formation = =

Prior to becoming a supernova , an evolved massive star is organized in the manner of an onion , with layers of different elements undergoing fusion . The outermost layer consists of hydrogen , followed by helium , carbon , oxygen , and so forth . Thus when the outer envelope of hydrogen is shed , this exposes the next layer that consists primarily of helium (mixed with other elements) . This can occur when a very hot , massive star reaches a point in its evolution when significant mass loss is occurring from its stellar wind . Highly massive stars (with 25 or more times the mass of the Sun) can lose up to 10 ? 5 solar masses (M ?) each year ? the equivalent of 1 M ? every 100 @,@ 000 years .

Type Ib and Ic supernovae are hypothesized to have been produced by core collapse of massive stars that have lost their outer layer of hydrogen and helium , either via winds or mass transfer to a companion . The progenitors of Types Ib and Ic have lost most of their outer envelopes due to strong stellar winds or else from interaction with a close companion of about 3 ? 4 M ? . Rapid mass loss can occur in the case of a Wolf @-@ Rayet star , and these massive objects show a spectrum that is lacking in hydrogen . Type Ib progenitors have ejected most of the hydrogen in their outer atmospheres , while Type Ic progenitors have lost both the hydrogen and helium shells ; in other words , Type Ic have lost more of their envelope (i.e. , much of the helium layer) than the progenitors of Type Ib . In other respects , however , the underlying mechanism behind Type Ib and Ic supernovae is similar to that of a Type II supernova , thus placing Type Ib / c between Type Ia and Type II . Because of their similarity , Type Ib and Ic supernovae are sometimes collectively called Type Ibc supernovae .

There is some evidence that a small percent of the Type Ic supernovae may be the progenitors of gamma ray bursts (GRB) ; in particular , type Ic supernovae that have broad spectral lines corresponding to high @-@ velocity outflows are thought to be strongly associated with gamma ray bursts (GRB) . However , it is also hypothesized that any hydrogen @-@ stripped Type Ib or Ic supernova could be a GRB , dependent upon the geometry of the explosion . In any case , astronomers believe that most Type Ib , and probably Type Ic as well , result from core collapse in stripped , massive stars , rather than from the thermonuclear runaway of white dwarfs .

As they are formed from rare , very massive stars , the rate of Type Ib and Ic supernovae

occurrence is much lower than the corresponding rate for Type II supernovae . They normally occur in regions of new star formation , and have never been observed in an elliptical galaxy . Because they share a similar operating mechanism , Type Ib / c and the various Type II supernovae are collectively called core @-@ collapse supernovae . In particular , Type Ib / c may be referred to as stripped core @-@ collapse supernovae .

= = Light curves = =

The light curves (a plot of luminosity versus time) of Type Ib supernovae vary in form , but in some cases can be nearly identical to those of Type Ia supernovae . However , Type Ib light curves may peak at lower luminosity and may be redder . In the infrared portion of the spectrum , the light curve of a Type Ib supernova is similar to a Type II @-@ L light curve . (See Supernova .) Type Ib supernovae usually have slower decline rates for the spectral curves than Ic .

Type Ia supernovae light curves are useful for measuring distances on a cosmological scale . That is , they serve as standard candles . However , due to the similarity of the spectra of Type Ib and Ic supernovae , the latter can form a source of contamination of supernova surveys and must be carefully removed from the observed samples before making distance estimates .