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STARBURSTS TRIGGERED BY CENTRAL OVERPRESSURE IN INTERACTING GALAXIES

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Abstract :

We propose a triggering mechanism for the origin of enhanced, massive-star formation in the central regions of interacting spiral galaxy pairs. Our mechanism is based on the detailed evolution of a realistic interstellar medium in a galaxy following an encounter. As a disk giant molecular cloud (GMC) tumbles into the central region following a galaxy encounter, it undergoes a radiative shock compression via the pre-existing high pressure of the central inter-cloud medium. The shocked outer shell of a GMC becomes gravitationally unstable and begins to fragment thus resulting in a burst of star formation, when the growth time for the gravitational instabilities in the shell becomes smaller than the crossing time of the shock. The resulting values of typical infrared luminosity agree with observations. For details, see Jog & Das (1992).

Cloud Compression via Central Overpressure:

We consider a galaxy with pre-encounter gas parameters as in the Galaxy, and study its evolution as it undergoes an enounter. Our model starts with the well-established fact (e.g., Norman 1990) that galaxy interactions cause an inflow of gas into the central region from the disk region within a galaxy. Further, recent observations of the Galaxy have shown the existence of a fairly uniform, gaseous, inter-cloud medium (ICM) in the central 1 kpc region (Bally et al. 1988). We note that the average pressure within the ICM is about 25 times greater than the internal pressure within a disk GMC.

We show that as a disk GMC arrives into the central region, it undergoes a radiative shock compression via the pre-existing high pressure of the ICM. The compression continues until the growth time for the gravitational instabilities in the shocked shell of a GMC becomes smaller than the shock crossing time. This is shown to occur when the mass of the shocked shell is about 80 % of the cloud mass. Beyond this point, the shell becomes unstable and this results in a burst of star formation.

Enhanced Star Formation and Resulting IR Luminosity:

The star formation in the shocked, high-density gas in a GMC shell is characterized by a high star formation efficiency and a preferential formation of massive stars of a few $M_\odot$ each (Larson 1986). The resulting IR luminosity depends linearly on the gas infall rate, the cloud mass fraction that is shock-compressed, and the star formation efficiency. Our mechanism yields a lower limit to the central infrared luminosity of $\sim$ 2-6 $*10^9$ $L_\odot$, and the infrared luminosity-to-gas mass ratio of a few $L_\odot/M_\odot$, in reasonable agreement with observations of central starbursts in tidally interacting galaxies. The evolved mergers, with their higher central gas concentrations, yield higher values of $\sim 10^{11}$-10^{12} $L_\odot$, and $\lesssim$ 100 $L_\odot/M_\odot$ respectively, which agree with the observed values for the central regions of evolved mergers (e.g., Telesco 1988).

Not all interacting galaxies show starbursts. One reason for this may be that the galaxy may not have a high-pressure ICM , as we show to be the case in M33. We can thus explain why M33 does not show a central starburst despite a close interaction with M31.

Conversely, an isolated, barred galaxy may show a central starburst if the central ICM pressure is greater than the internal pressure in a disk GMC, as we show to be the case in IC 342.

The central ICM appears to be a common feature of spiral galaxies, and its energetics and evolution need to be studied further.

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