STAR FORMATION IN GALACTIC NUCLEI

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ABSTRACT. The star formation in galactic open clusters leads, as a rule, to a complete disruption of the latter (Tutukov, 1978) because of the shallow potential wall of these clusters. The matter of dense galactic nuclei is in deep potential walls what drastically changes the star formation regime. The numerical dynamical model of the star formation in galactic nuclei with the mass $6 \cdot 10^9 M_\odot$ and the radius ~ 430pc was proposed by Loose et al (1982). It includes old and newly-formed stars, gas and dust distributed initially as in the center of our Galaxy. The model takes into account the star formation, supernova explosions, stellar winds, the turbulent motion of the gas component, non-grey radiative energy transfer, the influx of gas from old stars and from the outside. The main parameter of our model is the time of dissipation of the kinetic energy of the gas component τ_d. Supernova explosions are the main source of this energy. The results of numerical experiments help to point out two main regimes of the star formation in galactic nuclei: stationary and bursting. In the stationary regime the rate of the star formation is constant and it equals to the rate of the gas input. The formation of a long-living superstar is possible in this case (Krügel, Tutukov, 1986). In the bursting regime the periods of an active star formation alternate with those of almost a complete absence of the star formation. The main reason for supressing the star formation process is supernova explosions which throw the gas out of the galactic nuclei.

The change of the bolometric luminosity of all the nucleus in the course of bursts consists of the factor of 20, and for its central part - of about 300. The mass of the luminosity ratio during a burst is $10^{-2} - 10^{-1}$. Such a ratio was found by Rieke and Lebovsky (1978) for nuclei of many spiral galaxies. Models of infrared spectra and the radiofluxes of our models have shown a good agreement with the observed spectra and the fluxes of active nuclei.

E. Ye. Khachikian et al. (eds.), Observational Evidence of Activity in Galaxies, 533–535.

of M82 and NGC253 and many others (Krügel et al. 1983).

The regime of the star formation in a galactic nucleus depends, in the frames of our models, on the value of some dimensionless value α :

$$\alpha = \gamma \frac{S E_{SN} R}{GM} \quad \frac{\tau_\alpha}{\tau_{SN}}$$

This number is the ratio of the rates of the input and output of the gas-kinetic energy. τ_{SN} is the lifetime of of a presupernovae, S is the number of supernova per one gram of the gas trasforming into stars, E_{SN} is an average energy of a supernova and γ is a part of its energy what is the motion of the supernova envelope. M and R are the mass and the radius of a galactic nucleus.

The star formation is a stationary one if $\alpha < 1$ and it is nonstationary for $\alpha > 1$. For the fixed value of τ_α the main parameter determining the numerical value of α is the minimal mass of newly-forming stars that influence S . Numerical experiments have shown that if this mass is lower than $\sim M_\odot$ the star formation is a stationary one, and it is nonstationary if M_{min} is higher than the solar mass.

The period of the repetition of the burst of the star formation and the size of the star formation zone r can be easily estimated analytically. The distribution of old stars in nuclei is such that $M \sim R$. Therefore the most part of the gas lost by old stars appears initially on the outer border of the model. It takes the time τ to get the star formation region of the nucleus: $\tau = \tau_\alpha \ln(R/r)$. The accumulated mass of the gas M_g in this core may be estimated now from the simple condition $M_g \approx M \tau_\alpha / \tau_e \cdot \ln(R/r)$

where τ_e is the time of the mass loss by old stars. Since for the star formation the local gas density has to be equal to the star density and $M \sim r$ the last equation may be transformed to: $R/r \ln(R/r) \approx \tau_e / \tau_\alpha$.

This equation provides an estimation of r and therefore the bursts repetition time is $\tau_\alpha \ln(\frac{R}{r})$. It is evident from the last equation that the relative size of the star formation zone depends on the ratio of the time scale of replenishing gas to the dissipation time scale. Since $\tau_e \approx 10^{10}$ years, $\tau_\alpha \approx 10^7$ years, the radius of the star formation zone consists in this case only of several parsecs, and $\tau_\alpha \ln\frac{R}{r} \approx 10^8$ years. The duration of the star formation burst is of the order of τ_{SN}.

Dynamical computations have displayed that in the process of the burst of a star formation the appearance of high (up to several hundreds of km/s) velocities of the gas blowing away by supernovae envelopes from the very center of the model is possible. Newly-formed stars may also get rather high radial space velocities, after the disruption of the central cocoon of stars and gas.

Dynamical models with galactic nuclei with the star formation are an important means for interpretation of some types of the observed activity in galactic nuclei.

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https://doi.org/10.1017/S0074180900155573 Published online by Cambridge University Press