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Accretion of Gas by Globular Cluster Stars

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Abstract. We present here the results of detailed calculations which show that accretion of gas by main-sequence stars from a central reservoir in a globular cluster can be very effective, leading to major alterations of their surface abundances.

1. Introduction

Until recently, globular clusters appeared as chemically homogeneous groups of stars. However, the newer and more powerful telescopes now reveal a large diversity in the abundances of some chemical elements, not only for stars in separate globular clusters, but also for stars belonging to the same globular cluster. It is necessary to invoque several mecanisms to explain these inhomogeneities, some of them "primordial", i.e. created during the formation of the cluster, and some of them "evolutive", for example created by the accretion of interstellar matter by some stars. The Liège team has already proposed the accretion of gas by globular cluster stars to explain some chemical abundances correlations they observed in metal-poor field halo stars (Jehin et al., 1999) . Even though the process of accretion has been invoked in the past, detailed qualitative and quantitative calculations remained to be done.

Several factors must be present to insure effective accretion. In particular, the interstellar gas density must be large and the star must be in contact with the gas for a long time. These conditions can be fulfilled in a globular cluster if it is sufficiently large and concentrated to retain in its center the gas which is ejected by stars reaching the end of their lives. The cluster stars can then accrete matter from this "central reservoir of gas" when their orbit in the cluster brings them through this reservoir.

2. Results

We summarize in Table 1 the results we have obtained for a few clusters. We refer the reader to the paper by Thoul et al. (2002) for more details.

NGC	$m_a/m_{\rm cl,0}$ (%)	$m_{\rm esc}/m_{\rm cl,0}$ (%)	m_a/m_g (%)	$m_{\rm res}$ ($M_\odot$)	$m_{\rm knapp}$ ($M_\odot$)	m_a/m_i, (%)
104 (47Tuc)	2	0.2	98	<7	1	80
5139 (ωCen)	0.8	21	0.4	<542	14	0.1
5272 (M3)	5	16	24	<145	14	11
5904 (M5)	14	8	63	<140	7	40
6205 (M13)	4	17	18	<233	7	8
6341 (M92)	14	8	63	<33	34	37
6752	20	1	95	<1	5	76
7078 (M15)	4	18	16	<69	298	7

Table 1. Results obtained for a few clusters, at $t = 14$ Gy: m_a, total amount of gas that has been accreted by the cluster stars, $m_{\rm esc}$, amount of gas which has been lost from the cluster (swept when crossing the galactic plane), $m_{\rm res}$, the amount of residual gas in the cluster (varies between 0 just after crossing the galactic plane and its maximum value just before crossing the plane), $m_{\rm knapp}$ the upper limit of the observed dust and ionized gas, and the fraction of mass accreted by a 1 $M_\odot$ star (last column, $m_i = 1M_\odot$).

3. Conclusions

We have shown that accretion by low-mass Globular Cluster stars of the gas ejected in the intracluster medium by moderately massive stars may be quite efficient. If enough mass is accreted, it can lead to major alteration of the stellar surface composition. This supports the EASE scenario and provides a plausible explanation for the lack of intracluster gas, and for some of the abundance anomalies observed in Globular Cluster stars.

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References

Jehin E., Magain, P., Neuforge, C., Noels, A., Parmentier, G., & Thoul, A. 1999, A&A341, 241

Thoul, A., Jorissen, A., Goriely, S., Jehin, E., Magain, P., Noels, A., & Parmentier, G. 2002, A&A, 383, 491