



## **Origin of the Elements and Nuclear History of the Universe (EuroGENESIS)**

**EuroGENESIS Review Panel**

### **Final Evaluation Consensus Report**

The goal of the EuroGENESIS programme, to improve the knowledge of the origin of the elements and the nuclear history of the universe, has been reached by the different Collaborative Research Projects (CRPs) with great success. Progress has been achieved through joint efforts of researchers working on astrophysics modelling and observations, measurement of nuclear reactions and isotopic assessment of meteorites. The interdisciplinary collaborations fostered by this programme have been one of its main strengths and the programme has acted as a platform enabling these communities to work together. EuroGENESIS has strengthened the field of nuclear astrophysics in Europe allowing it to flourish beyond the end of this programme.

#### **1. Progress in the Collaborative Research Projects (CRPs)**

All of the CRPs made significant contributions to the programme. Some of the scientific highlights include:

- Progress in understanding nucleosynthesis in supernovae
- Progress in understanding of the origin of the r-process site (MASCHE)
- Advances in the understanding of dust formation in supernovae and its reprocessing in supernovae remnants (CoDustMas)
- Study of the ignition of type Ia supernovae (EXNUC)
- Development of the first 3D hydrodynamical stellar model atmospheres with a detailed description of radiative transfer (FirstStars)
- Improved nuclear physics input for astrophysical models including improved masses and reaction rates
- Addressing the evolution of lithium in the early Galaxy and clarification of the outstanding issue of detection of  ${}^6\text{Li}$  in metal-poor stars (FirstStars)

- Explanation of the Inter Stellar Medium (ISM) cavity sizes by the action of massive stars groups (MASCHE)

A large number of refereed publications have been published in the best journals in the respective fields (Nature, Astrophysical Journal, Astronomy and Astrophysics, Physical review, etc.). However, the amount of publications listed is so large that it is impossible that they all originate to a significant extent from work undertaken in the framework. It is likely that some of the projects would have been carried out also without EuroGENESIS and a large number of publications would have been produced anyway. In addition, only a small part of the publications listed in the reports are acknowledging the support by EuroGENESIS. A better selection of publications would have been appropriate to assess the real impact of EuroGENESIS.

## **2. Programme Integration**

The EuroGENESIS programme provided excellent opportunities for cross fertilisation between different subfields of nuclear astrophysics. This opportunity was extensively used by most of the CRPs and collaborations were established between groups which otherwise would not have collaborated. It can be expected that these collaborations continue after the end of the programme and that they will bring added value at the European level.

It appears that a very good level of integration within the teams has been achieved. This is visible from a number of joint publications reported, scientific meetings, training schools and workshops organized within this programme. Annual progress meetings have also been held. The strongest collaboration was, naturally, within individual CRPs, i.e. their groups. Collaboration on a higher level, i.e. within the four CRPs was also present, giving a clear added value achieved by this Programme. However, this collaboration was not equally distributed across the four CRPs. There was a high level of interaction between CoDustMas, MASCHE, and EXNUC. The focus of EXNUC on binary systems and FirstStars on early evolution of the Galaxy complemented the focus on core collapse supernovae in the other two CRPs. The impression is that the CRP MASCHE played a lead role in building up collaboration among all CRPs and groups, initiated many activities, and took effort to collaborate with all the other CRPs. On the other hand, the FirstStars CRP, though adding some high-level scientific highlights to this programme, was less involved in collaboration with the other groups (except with MASCHE).

Although in some cases, there was a lack of synergies between Individual Projects, one may state as a general assessment that even if all groups have performed research in their respective fields, a new aspect emerged from intra- and inter-CRPs activities. In particular, data from nuclear experiments entered into stellar models and explosion simulations; comparisons of different techniques for modelling stellar evolution have been performed in greater detail; observational constraints were better understood due to direct discussions with the observers, and new research activities have been initiated. These joint community activities led to much more productive and directed research efforts and to some results that would not have appeared otherwise.

### **3. Networking, Training and Dissemination**

The overall intensity of networking, training and dissemination can be rated as very good for the whole Programme. The scientific output has been presented in many conferences by all four CRPs. Regarding networking, CRPs MASCHE and EXNUC took more initiative to organize joint workshops and meetings of interest for the full programme, than the other two CRPs. Annual progress meetings were held. CRP EXNUC was very active in organizing schools, workshops and other training activities which was especially useful for PhD students. CoDustMas recruited 5 young PhD students, giving them the opportunity to get training in a relatively new field of astrochemistry. Dissemination of scientific results through conferences was on a very high-level for all 4 CRPs. Public outreach (public talks, media appearance) was also on a very high-level for all CRPs except for CoDustMas. This can be understood, given that a new young group was formed in this case. Public outreach is often not depending only on the willingness of scientists to participate, but also on the work of institutional public relation services, and whether scientists are already popular amongst the public and get invited by the media. Therefore, for future initiatives of this kind, it would be useful if ESF would offer additional help in organizing public outreach on international level in order to disseminate results of funded CRPs, and help new fields and groups become more visible.

### **4. General comments and other feedback**

In conclusion, EuroGENESIS was a successful programme that helped integrate research across fields and different countries to address some of the most important questions regarding astrophysical objects and their role in the chemical evolution of the Galaxy. The programme fostered collaborations that one can expect to continue in the future, provided that adequate funding mechanisms for supporting this highly interdisciplinary field of science are made available. Smaller countries have greatly benefitted from this programme as it allowed young researchers to be integrated in a research network across Europe. The programme served as a counterpart to the Physics Frontiers Centre in the US (the Joint Institute for Nuclear Astrophysics), and helped to increase the impact of European research in the broader research areas of astrophysics and nuclear physics.

AH/CL  
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