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Present status of the KADoNiS database

Iris Dillmann[*†]
Forschungszentrum Karlsruhe, Institut für Kernphysik, Postfach 3640, D-76021 Karlsruhe and Departement Physik und Astronomie, Universität Basel, Klingelbergstrasse 82, CH-4056 Basel
E-mail: iris.dillmann@ik.fzk.de

Ralf Plag, Michael Heil, and Franz Käppeler

Forschungszentrum Karlsruhe, Institut für Kernphysik, Postfach 3640, D-76021 Karlsruhe

Thomas Rauscher

Departement Physik und Astronomie, Universität Basel, Klingelbergstrasse 82, CH-4056 Basel

The "Karlsruhe Astrophysical Database of Nucleosynthesis in Stars" (KADoNiS) project is an online database for experimental cross sections relevant to the *s* process and *p* process. It is available under *http://nuclear-astrophysics.fzk.de/kadonis* and consists of two parts. Part 1 is an updated sequel to the well-known Bao et al. compilations from 1987 and 2000, which is online since April 2005. An extension of this *s*-process database to (n,p) and (n,α) cross sections at kT= 30 keV, as in the first version of the Bao compilation, is planned. The second part of KADoNiS is a *p*-process library, which includes all available experimental data from (p,γ), (p,n), (α,γ), (α,n), (α,α), (n,α) and (γ,n) reactions in or close to the respective Gamow window. Despite the great number of reactions required for a *p*-process reaction network, experimental data is still scarce and up to now restricted to stable targets. Given here is a short overview about the present status of the KADoNiS database.

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1. History of stellar neutron capture compilations

The first collection of stellar neutron capture cross sections was published in 1971 by Allen and co-workers [1]. This paper reviewed the role of neutron capture reactions in the nucleosynthesis of heavy elements and presented also of a list of recommended (experimental or semi-empirical) Maxwellian averaged cross sections at kT= 30 keV (MACS30) for nuclei between carbon and plutonium (6≤Z≤94). The idea of an experimental and theoretical stellar neutron cross section database was picked up again by Bao and Käppeler [2] for *s*-process studies. This compilation published in 1987 included cross sections for (n,γ) reactions (between ^{12}C and ^{209}Bi), some (n,p) and (n,α) reactions (^{33}Se to ^{59}Ni), and also (n,γ) and (n,f) reactions for long-lived actinides. A (limited) updated compilation was published in 1992 by Beer, Voss and Winters [3].

In the update of 2000 [4] the Bao compilation from 1987 was extended to isotopes between ^{1}H and ^{209}Bi, and listed – like the original Allen paper – also semi-empirical recommended values for nuclides without experimental cross section information. These estimated values are normalized cross sections derived with the Hauser-Feshbach code NON-SMOKER [5], which account for known systematic deficiencies in the nuclear input of the calculation. Additionally, the database provided stellar enhancement factors and energy-dependent MACS for energies between kT= 5 keV and 100 keV.

2. The updated big bang and *s*-process database

The first update of the big bang and *s*-process database was finished in January 2006 [6]. In this stage, eight theoretical cross sections (^{74}Se, ^{84}Sr, $^{128-130}$Xe, ^{147}Pm, ^{151}Sm, and ^{180}Ta^{m}) were replaced with new experimental values. Further 20 cross sections were updated by the inclusion of new data. In order to make these updates reproducible, a full list of updated cross sections with references can be found on the KADoNiS homepage in the menu section "Logbook". Here will be also a history of previous KADoNiS versions.

The main future efforts in this part will be focussed on the re-evaluation of semi-empirical cross sections and the re-calculation of cross sections for isotopes, where a recent change in physical properties (e.g. $t_{1/2}$, I_γ...) leads to changes in already measured cross sections. Another module will be the extension to (n,p) and (n,α) cross sections at kT= 30 keV, as in the first version of the Bao compilation [2].

3. The new *p*-process database

The second part of KADoNiS is a collection of all experimental reaction rates relevant for *p*-process studies. The first stage is presented here and includes all available datasets of (α,γ) (Table 1) and (p,γ) (Table 2) reactions within the respective Gamow window (see column E_{Gamow}).

These tables are listed under *http://nuclear-astrophysics.fzk.de/kadonis/pprocess*, including hyperlinks to the respective EXFOR files. In the present stage (July 2006) we have included 39 (p,γ) datasets of 32 isotopes between ^{58}Ni and ^{119}Sn, and 9 (α,γ) reactions. For these isotopes we have created datasheets similar to those in the *s*-process database, which include tabulated cross sections data, from which the respective *S* factor and reaction rate is calculated. As additional information, a graphical plot of the dataset(s) with the location of the Gamow window is given. A

Isotope	Reaction	E_{exp} $[MeV]$	E_{Gamow} $[MeV]$	Reference	EXFOR Entry
^{56}Fe	(α,γ)	3.90 - 6.50	3.21 - 6.86	[7]	A0308
^{58}Ni	(α,γ)	4.90 - 6.10	3.40 - 7.18	[8]	C0703
^{62}Ni	(α,γ)	5.10 - 8.60	3.40 - 7.19	[9]	C0669
^{64}Ni	(α,γ)	4.40 - 7.10	3.40 - 7.20	[9]	C0669
^{63}Cu	(α,γ)	5.90 - 8.70	3.49 - 7.34	[10]	C1050
^{70}Ge	(α,γ)	5.05 - 7.80	3.78 - 7.80	[11]	O0897
^{96}Ru	(α,γ)	7.03 - 10.56	4.85 - 9.51	[12]	A0451
^{112}Sn	(α,γ)	8.30 - 9.97	5.32 - 10.30	[13]	C0904
^{144}Sm	(α,γ)	10.50 - 13.40	6.26 - 11.78	[14]	A0416

Table 1: List of (α,γ) reactions within the Gamow window (E_{Gamow}), which are included in the *p*-process library.

graphical comparison with theoretical predictions from MOST [15] and NON-SMOKER [5] will also be included.

Up to the end of 2006 we plan to extend this database also to other available reactions, e.g. (p,n), (p,α), (α,n), (α,p), (n,α) and (n,p) reactions. A further step will be the inclusion of photodissociation rates, and the calculation of those rates from (n,γ) reactions via detailed balance. Although KADoNiS is thought to be a "dynamic" database, which is updated regularly, a paper version will be published in 2007.

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Isotope	Reaction	E_{exp} $[MeV]$	E_{Gamow} $[MeV]$	Reference	EXFOR Entry
^{58}Ni	(p,γ)	1.32 - 2.74	1.14 - 3.22	[16]	A0696
^{58}Ni	(p,γ)	1.00 - 4.91	1.14 - 3.22	[17]	C0886
^{58}Ni	(p,γ)	0.51 - 3.09	1.14 - 3.22	[18]	A0048
^{58}Ni	(p,γ)	1.14 - 4.09	1.14 - 3.22	[19]	A0311
^{60}Ni	(p,γ)	0.61 - 2.94	1.14 - 3.22	[18]	A0048
^{61}Ni	(p,γ)	1.11 - 2.94	1.14 - 3.22	[18]	A0048
^{64}Ni	(p,γ)	1.11 - 2.94	1.14 - 3.22	[20]	A0198
^{63}Cu	(p,γ)	1.11 - 4.69	1.17 - 3.29	[20]	A0198
^{63}Cu	(p,γ)	1.99 - 4.52	1.17 - 3.29	[21]	C0739
^{65}Cu	(p,γ)	1.03 - 3.22	1.17 - 3.29	[20]	A0198
^{65}Cu	(p,γ)	1.99 - 4.52	1.17 - 3.29	[21]	C0739
^{64}Zn	(p,γ)	1.47 - 2.73	1.21 - 3.35	[18]	A0048
^{67}Zn	(p,γ)	1.47 - 2.92	1.21 - 3.35	[18]	A0048
^{68}Zn	(p,γ)	1.67 - 4.97	1.21 - 3.35	[22]	C0650
^{74}Se	(p,γ)	1.60 - 3.00	1.34 - 3.61	[18]	A0048
^{74}Se	(p,γ)	1.46 - 3.55	1.34 - 3.61	[23]	O0849
^{76}Se	(p,γ)	1.46 - 3.55	1.34 - 3.61	[23]	O0849
^{77}Se	(p,γ)	1.55 - 2.97	1.34 - 3.61	[18]	A0048
^{84}Sr	(p,γ)	1.67 - 2.96	1.47 - 3.85	[24]	A0426
^{86}Sr	(p,γ)	1.48 - 2.96	1.47 - 3.85	[24]	A0426
^{87}Sr	(p,γ)	1.58 - 2.96	1.47 - 3.85	[24]	A0426
^{88}Sr	(p,γ)	1.38 - 4.94	1.47 - 3.85	[25]	O1054
^{89}Y	(p,γ)	1.76 - 4.83	1.51 - 3.91	[26]	O1182
^{90}Zr	(p,γ)	1.97 - 5.70	1.54 - 3.97	[27]	
^{96}Zr	(p,γ)	3.50 - 6.00	1.54 - 3.97	[28]	C0556
^{93}Nb	(p,γ)	1.42 - 4.80	1.57 - 4.03	[29]	O0918
^{92}Mo	(p,γ)	1.48 - 3.00	1.60 - 4.08	[30]	A0653
^{94}Mo	(p,γ)	1.48 - 2.49	1.60 - 4.08	[30]	A0653
^{95}Mo	(p,γ)	1.70 - 3.00	1.60 - 4.08	[30]	A0653
^{98}Mo	(p,γ)	1.48 - 3.00	1.60 - 4.08	[30]	A0653
^{96}Ru	(p,γ)	1.65 - 3.37	1.66 - 4.20	[31]	A0654
^{98}Ru	(p,γ)	1.65 - 3.37	1.66 - 4.20	[31]	A0654
^{99}Ru	(p,γ)	1.46 - 3.37	1.66 - 4.20	[31]	A0654
^{100}Ru	(p,γ)	1.46 - 3.37	1.66 - 4.20	[31]	A0654
^{104}Ru	(p,γ)	1.65 - 3.37	1.66 - 4.20	[31]	A0654
^{102}Pd	(p,γ)	2.53 - 4.17	1.72 - 4.31	[13]	C0904
^{112}Sn	(p,γ)	3.00 - 8.50	1.84 - 4.52	[28]	C0556
^{116}Sn	(p,γ)	2.63 - 4.18	1.84 - 4.52	[13]	C0904
^{119}Sn	(p,γ)	2.80 - 6.00	1.84 - 4.52	[28]	C0556

Table 2: List of (p,γ) reactions within the Gamow window (E_{Gamow}), which are included in the *p*-process library.