^{19}F(n,t),(d,α),(α,^{6}Li) 2015Fa12

History

Type	Author	Citation	Literature Cutoff Date
Full Evaluation	C. G. Sheu, J. H. Kelley, J. Purcell	ENSDF	5-Aug-2021

1968Re07: ^{19}F(n,t), E=14.4 MeV; measured $\alpha(E_t,\theta)$.

2011Ko29: ^{19}F(n,t), E=14.2 MeV; measured reaction products; deduced $\sigma(\theta,E)$.

1960Hu10: The experiment was performed at the Osaka University 44-inch cyclotron from an E=11.4 MeV deuteron beam bombardment of a Teflon film (0.9 mg/cm^2) at θ_{lab}=30°. Alpha particles were detected by a thin uniform CsI(Tl) crystal on a R. C. A. 6342 photomultiplier. The angular distributions were measured at $\theta_{c.m.}\approx$25°−16−°. The ^{17}O ground state and the first excited state (0.872 MeV) were observed.

1960Ri05: ^{19}F(d,α), E=1.8 MeV; $Q_{g.s.}$ for ^{17}O=10.059 MeV *10*. ^{17}O*(0.878 *6*, 3.071 *12*, 3.866 *10*, 4.570 *30*, 5.245 *12*, 5.408 *20*, 5.726 *8*, 5.758 *15*, 5.897 *12*, 5.961 *20* MeV) observed (see Table 3)).

1961Ci02: An E_d=13 MeV beam impinged on a 7-10 mg/cm^2 Teflon foils in a 30 cm diameter scattering chamber at the Center of Nuclear Physics in Cracow, Poland/120 cm cyclotron. Particles were detected by a thin scintillator placed at a distance of 30 cm from the target and identified by a 100-channel amplitude analyzer with the energy resolution of ≈7-9%. The absolute cross sections were measured by means of a beam integrator with a reliability better than 5%. The excitation functions of ^{17}O ground state (l=2, 4) and the first excited state (l=0 (best fit), 2) were observed at θ_{lab}=25°−145°.

1962Ta07: A deuteron beam of E=14.7 MeV obtained from the Kyoto University 105 cm cyclotron bombarded a 0.76 mg.cm^2 Teflon film. A solid state detector of the Si p-n junction of RCA Vicotr Type-C operated with the reverse bias voltage of 200 volts was used to detect α particles with the angular spread ±1.5°. The alpha spectrum was measured and the uncertainty of the absolute differential cross setions was estimated to be <30%. Excitation functions of ^{17}O*(g.s.(5/2$^+$),0.87(1/2$^+$),3.058(1/2$^-$),3.846(7/2) and 4.555 MeV(3/2$^-$)) were deduced.

1964Ja08: Deuterons at E=2-3 MeV from the University of Texas electrostatic accelerator at Balcones Research Center impinged on a target, prepared by vacuum evaporation of calcium fluoride onto a 0.2 mg/cm^2 gold foil. The thickness of the calcium fluoride was ≈40 keV at 2.5 MeV based on energy resolution of the observed α-particles. Alpha particles were detected using a semiconductor detector and were analyzed by a 100-channel pulse-height analyzer. The differential cross sections of the five lowest states in ^{17}O were measured at θ_{lab}=70° with an uncertainty of 50% (for the absolute cross sections) and of ±8% (for the relative cross sections). Total cross sections were compared with 2I+1 rule where I is the spin of the residule nucleus.

1964Ma04: The angular distributions for the reaction ^{17}F(d,α)^{17}O*(0,0.872 MeV) were measured from an E_d=27.5 MeV *1* beam bombardment of a 1.13 mg/cm^2 *4* Teflon film at the 180-cm Buenos Aires cynchrocyclotron. Measurements were performed at θ_{lab}=15°−12−°, in 5° intervals for the forward, and 10° intervals for the backward hemisphere. Alpha particles were detected using a solid-state detector with a energy resolution of ≈1%.

1965Co07,1965Co09: The differential cross sections for the ^{19}F(d,α) reaction were measured at the Purdue University/37-inch cyclotron. Thin Teflon targets (370-720 μg/cm^2) were bombarded with 9.2-MeV deuteron beams. Alpha particles were detected using Si surface-barrier detectors and were identified with a 256-channel pulse-height analyzer. The azimuthal acceptance angle of the detector was 2.3° and the nominal solid angle subtended by the detector was 0.001 sr. Alpha spectra were obtained at 46 angles in the range of θ_{lab}=10°−172.5°. The systematic uncertainty of the absolute cross sections is ±15%. The energe levels of ^{17}O ground state and the lowest four excited states were observed. The 2I+1 rule was discussed.

1965El01: Deuterons at E=1-2.5 MeV produced by the 2.5 MeV electrostatic accelerator of the UAR Atomic Energy Establishment impinged on a 0.7 mg/cm^2 CaF_2 target (evaporated on a thin silver backing). The emitted α particles were detected using a semiconductor detector and were fed into a ORTEC-100α-40 charge amplifier and a 400 or 512-channel pulse-height analyzer with the resolution ≤1%. The ground state and the first nine excited states of ^{17}O were deduced.

1965St14: A beam of 950-1250 keV deuterons, from the 1.5 MeV Cockcroft-Walton accelerator/Boris Kidrich Institute bombarded a 0.35 mg/cm^2 CaF_2 (evaporated on nickel) target. Reaction particles were detected using Si surface-barrier counters and were fed to the amplifiers (ORTEC type 103, 203) and a 512-channel pulse-height analyzer. The energy resolution for the α_0 group was about 100 keV. The α_{1-3} groups have total cross sections consistent with the 2I+1 law as expected. The ground state and the first four excited states of ^{17}O were resolved.

1966We04: A deuteron beam at E=5.5, 6.5, 7.5, 8.5, 9.5 and 11.5 MeV from the Lawrence Radiation Laboratory/90-in. variable-energy cyclotron impinged on a 0.60 mg/cm^2 Teflon (Cf_2) target. Three Si surface-barrier detectors, mounted in fixed positions on a curved brass arm at 10° intervals, covered a solid angle $\Delta\Omega=0.406\times10^{-3}$ sr with an angular spread of ±0.6°. Alpha particles were observed by a solid-state counter. Angular distributions for the ground and first four excited states of ^{17}O were measured at θ_{lab}=7.5°−163° in 5° intervals. Reasonable fits by DWBA theory were obtained only for the $^{17}O_{g.s.}$ state distributions at higher bombarding energies.

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1968Bi09: ^{19}F(d,α), E=2.0,2.2 MeV; measured σ(E$_α$,θ); deduced ^{17}O level properties.

1968Pr04: The differential cross sections corresponding to the production of the first three and first two residual states in the reactions ^{19}F(d,α)^{17}O and ^{15}N(d,α)^{13}C were measured at θ=17°−170° and θ=17°−112°, respectively. A deuteron beam at E=21.0 MeV *1* bombarded either a ^{19}F target (1.43 mg/cm^2 *5* comercial films of Teflon, Cf_2) or a ^{15}N gas target (99% purity) at the Lewis Research Center. The over-all energy resolution was ≈300 keV FWHM and the systematic error in the absolute differential cross section was ≈15%. The angular distributions were fitted by the cutoff DWBA calculations and the best fit was obtained for the ^{19}F(d,α$_1$) reaction which proceeded primarily by L=0 orbital-angular-momentum transfer.

1968Ta02: The deuterons accelerated by the 5 MV Van de Graaff accelerator at Tohoku University impinged on a CaF_2 target. Two semi-conductor, suface-barrier detectors separated by 45° were placed on a turntable scattering chamber with an inner diameter, 14 cm. Five lowest states of ^{17}O were observed at θ=90° and 135° for the energy range E$_d$=0.9-4.25 MeV in steps of 50 keV. The 2J+1 rule was also examined.

1968Za03: ^{19}F(d,α), E=2.4-3.95 MeV; measured σ(E; E$_α$,θ), observed α$_0$, α$_1$, α$_2$ and α$_3$; deduced reaction mechanism.

1969Li22: The deuterons produced in the 3 MeV Van de Graaff Accelerator at the National Tsing Hua University in China, impinged on a 150 μg/cm^2 CaF_2 target. A surface-barrier Si detector (SSD) was used to detect α particles. The excitation functions were measured with E$_d$=1.35-2.15 MeV in steps of 50 keV at θ$_{lab}$=90° and 160°. The angular distributions of four α groups, α$_{0-3}$ were measured at θ=50°−160° in 10° intervals and compared with the 2*I*+1 rule where *I* is the spin of the residual nucleus.

1969Me07: A beam of 300-650 keV deuterons, from the cascade generator of ATOMKI/Institute of Nuclear Research, Debrecen, Hungary impinged on a 0.5 mg/cm^2 CaF_2 target (evaporated onto a Cu foil). The α$_{0-3}$ angular distributions were measured at ten different energies with a plastic track detector and a semiconductor detector (ORTEC SBCJ-25-300).

1970So12: ^{19}F(d,α$_{0,1,2,3}$), E=600,650 keV; measured σ(E$_α$,θ).

1972La18: ^{19}F(d,α),(d, p), E=3 MeV; measured σ(Ep,θ).

1976Bi03: ^{19}F(d,α), E=2.34-14.45 MeV; measured σ(E,Eα,θ); deduced reaction mechanism.

1979An35: ^{19}F(pol. d,α), E=1.8-3 MeV; measured σ(Eα), analyzing power iT11(E,θ$_α$), iT11(E,θ$_d$).

1981Ma46: ^{19}F(d,α), E=410.7 keV-1.9 MeV; measured products, ^{17}O, 2-He-4; deduced σ(θ).

2000El08: ^{19}F(d,α), E=0.7-3.4 MeV; measured Eγ, Iγ; deduced thick target γ-ray yields.

2012Pa34: ^{19}F(d,α), E=1.8-3 MeV; measured Eα, Iα; deduced σ(θ). Comparison with available data, SIMNRA code calculations.

2015Fa12: XUNDL dataset compiled by TUNL, 2015.

The authors studied ^{17}O levels in the E$_x$=4 to 8 MeV to better characterize their roles in astrophysical neutron production, via the ^{13}C(α,n) reaction , and absorption, via the ^{16}O(n,γ) reaction.

A beam of 22 MeV deuterons, from the Maier-Leibnitz Laboratory in Munich, impinged on a 46 μg/cm^2 ^{6}LiF target that was evaporated onto a 12 μg/cm^2 carbon backing. The reaction products were momentum analyzed using a Q3D spectrograph and detected in the focal plane with a position sensitive proportional counter. Measurements were carried out at θ=10° and 15° covering E$_x$=3750 to 6200 keV and 5500 to 7800 keV, respectively, with an energy resolution of 20 keV (FWHM) that was mainly attributed to the energy loss difference of d′s and α′s in the target. The peaks of the spectrum were fitted with a convolution of Lorentzian and Gaussian shapes; for broader shapes, the Lorentzian Γ was deduced, for narrower resonances only the FWHM is provided.

The present results are compared with literature values and discussed in the context of their astrophysical relevance. Particular attention is given to the parameters of the E$_x$≈6360 keV state, which is closest to the ^{13}C(α,n) threshold at 6358.69 keV.

See also (1962Fo02).

1968Mi05: ^{19}F(α,^{6}Li), a study leading to the ground and first excited states of ^{17}O.

1995Fa21: ^{19}F(α,^{6}Li), E=27.2 MeV; measured σ(θ); deduced model parameters, spectroscopic factors. Finite-range DWBA.

^{17}O Levels

Notes:

Bu51: Proc. Roy. Soc. A209, 478 (1951). ^{19}F(d,α) E$_d$=7.9 MeV.

Wa52: Phys. Rev. 88, 1324 (1952).

Go56: Physica 22, 1159,73. (1956).

Atomic mass of ^{17}O=17.000139 u *12* (1960Ri05).

For the ground state and up to the fifth excited states observed, see also (1960Hu10, 1961Ci02, 1962Ta07, 1964Ja08, 1964Ma04, 1965Co07, 1965Co09, 1965St14, 1966We04, 1968Pr04, 1968Ta02, 1968Za03, 1969Li22, 1969Me07, 1972La18, 1976Bi03,

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^{17}O Levels (continued)

1981Ma46, 2012Pa34). See also (1968Mi05: ^{19}F(α,^{6}Li)^{17}O*(g.s.,0.873), 1995Fa21: ^{19}F(α,^{6}Li)$^{17}O_{g.s.}$).

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^{19}F(n,t),(d,α),(α,^{6}Li) 2015Fa12 (continued)

^{17}O Levels (continued)

E(level)[†]	J$^{\pi}$[‡]	Γ[†]	L	FWHM (keV)[†#]	Comments
0[bc]	5/2$^+$		2,4		L: See (1960Hu10,1961Ci02,1962Ta07,1965St14,1968Pr04, 1976Bi03).
879.0[bc] *52*	1/2$^+$		0,2		E(level): wieghted average from (Bu51: 870 keV *50*), (Wa52: 883 keV *11*) and (1960Ri05: 878 keV *6*). See also E$_x$=870 keV 20 (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations.). L: See (1961Ci02,1962Ta07,1968Pr04,1976Bi03).
3069.2[b] *76*	1/2$^-$		1		E(level): wieghted average from (Bu51: 3030 keV *60*), (Wa52: 3069 keV *10*) and (1960Ri05: 3071 keV *12*). See also E$_x$=3060 keV 30 (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reactions calculations.). L: See (1968Pr04).
3842.9[@ab] *4*	5/2$^-$			21.52 *21*	E(level): See also E$_x$(keV)=3830 *40* (Bu51), 3850 *30* (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations), 3856 *11* (Wa52) and 3866 *10* (1960Ri05).
4551.4[&ab] *7*	3/2$^-$	38.1 keV *28*		48.2 *17*	E(level): See also E$_x$(keV)=4560 *30* (Bu51), 4580 *20* (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations), 4567 *14* (Wa52) and 4570 *30* (1960Ri05).
5087.7[&] *10*	3/2$^+$	88 keV *3*		93.4 *26*	E(level): See also E$_x$(keV)=5080 *30* (Bu51), 5070 *20* (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations).
5216.5[@ab] *4*	9/2$^-$			21.6 *5*	E(level): See also E$_x$(keV)=5310 *60* (Bu51), 5310 *20* (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations), 5229 *13* (Wa52), 5245 *12* (1960Ri05) and (1965El01: 5.23+5.40 MeV unresolved).
5388.8[&b] *6*	3/2$^-$	39.0 keV *21*		49.4 *11*	E(level): See also E$_x$(keV)=5397 *14* (Wa52) and 5408 *20* (1960Ri05).
5697.5[@ab] *5*	7/2$^-$			21.97 *14*	E(level): See also E$_x$(keV)=5660 *30* (Bu51), 5760 *20* (Bu511: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations), 5723 *14* (Wa52) and 5726 *8* (1960Ri05).
5731.6[@ab] *4*	(5/2$^-$)			21.97 *14*	E(level): See also E$_x$(keV)=5758 *15* (1960Ri05) and (1965El01: 5.71+5.86+5.85 MeV unresolved).
5869.7[@a] *6*	3/2$^+$			25.2 *7*	E(level): See also E$_x$(keV)=5875 *15* (Wa52) and 5897 *12* (1960Ri05).
5931.0[&] *11*	1/2$^-$	33 keV *5*		44.7 *30*	E(level): See also E$_x$(keV)=5947 *15* (Wa52) and 5961 *20* (1960Ri05).
6363.4[&] *31*	1/2$^+$	136 keV *5*		139 *4*	E(level): See also E$_x$(keV)=6210 *30* (Bu51) and 6240 *20* (Bu51: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations).
6860.7[@a] *4*	(5/2$^+$)			18.8 *7*	E(level): See also E$_x$(keV)=6910 *30* (Bu51), 6890 *30* (Bu511: mean energy value of ^{19}F(d,α) and ^{16}O(d,p) reaction calculations) and 6869 *14* (Wa52).
6972.6[@a] *4*	(7/2$^-$)			18.8 *4*	E(level): See also E$_x$(keV)=(6986 *15*) (Wa52).
7165.4[@a] *18*	5/2$^-$			20.0 *5*	
7216[&] *4*	3/2$^+$	262 keV *7*		264 *7*	
7380.1[@] *4*				19.8 *5*	Unresolved E$_x$=7379 (5/2$^+$) and 7382 (5/2$^-$) states. E(level): See also E$_x$(keV)=(7371 *15*) (Wa52).
7510 *30*	3/2$^-$				E(level): from (Bu51).
7573.5[@a] *6*	(7/2$^+$)			18.4 *12*	

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^{19}F(n,t),(d,α),(α,^{6}Li) 2015Fa12 (continued)

^{17}O Levels (continued)

E(level)[†]	Jπ[‡]	Γ[†]	FWHM (keV)[†#]	Comments
7689.2[&a] *6*	7/2−	12 keV *4*	25.1 *13*	
7763.6[@a] *4*	11/2−	<4 keV	18.1 *7*	
8270? *40*				E(level): from (Bu51).
8590? *40*				E(level): from (Bu51).
9060? *40*				E(level): from (Bu51).

[†] From (2015Fa12) except where noted.
[‡] Nominal values listed in (2015Fa12).
[#] The peaks of the spectrum were fitted with a convolution of Lorentzian and Gaussian shapes; for broader shapes, the Lorentzian Γ was deduced, for narrower resonances only the FWHM is provided and that could be regarded as an upper limit.
[@] Fit with Gaussian shape.
[&] Fit with Lorentzian shape.
[a] Used for energy calibration.
[b] Also observed in (1968Bi09).
[c] Also observed in (1968Re07,2011Ko29).

γ(^{17}O)

E_γ	E_i(level)	J^π_i	E_f	J^π_f	Comments
879	879.0	1/2+	0	5/2+	E_γ: see (2000El08: 870.7 keV).
2200	3069.2	1/2−	879.0	1/2+	E_γ: from (Go56). The absence of the direct ground state decay of the 3.07-MeV state is consistent with J=1/2 (Go56).
3842.9	3842.9	5/2−	0	5/2+	E_γ: from (Go56).

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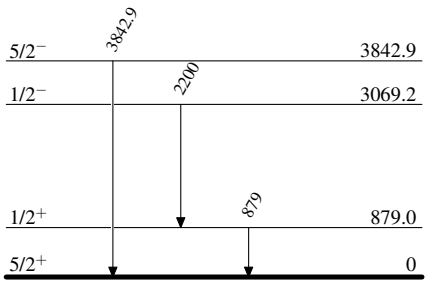
Level Scheme



$^{17}_{8}O_9$