Adopted Levels

Q(β^-)=−1.890×10^4 *5*; S(n)=2.018×10^4 *11*; S(p)=−322 *11*; Q(α)=−6.31×10^3 *6* 2012Wa38

For discussion on energy shifts and the Isobaric Multiplet Mass Equation (IMME) for the A=19 T_z=3/2 isobars see (Cerney, Ann Rev Nucl Sci 18 (1968) 27, 1969Ce01, 1969Mu09, 1975Be38, 1988Co15, 2013Ho01, 2014Yu02).

For other general theoretical predictions see (1975Ca27, 1977Sh13, 1978Gu10, 1987Po01, 2003Jh01, 2004Ge02, 2005Ma98, 2008Qi04, 2010Pe15).

^{19}Na Levels

Cross Reference (XREF) Flags

- A P(^{18}Ne,p):resonances
- B ^{9}Be(^{20}Mg,^{19}Na)
- C ^{24}Mg(p,^{6}He)
- D ^{24}Mg(^{3}He,^{8}Li)

E(level)	J^π	Γ	L	S	XREF	Comments
0	(5/2$^+$)	<40 keV			BCD	%p≈100 (2010Mu12) state that Γ<40 keV reflects the experimental resolution of the detector system. The actual Γ is expected to be <1 eV. Decays to ^{18}Ne$_{g.s.}$
120 *10*	(3/2$^+$)				D	%p≈100 Decays to ^{18}Ne$_{g.s.}$
745 *12*	1/2$^+$	101 keV *3*	0		A	%p≈100 E(level),J^π,Γ,L: from (2003An02). Others: (2005De15,2006Sk09). E_{res}(cm)=1066 keV *3* (2003An02). E(level): the corresponding level is at 1471.7 keV in the mirror nucleus ^{19}O.
2459† *32*	(5/2,3/2)$^+$†	105† keV *10*		0.43† *5*	A	%p≈100 Decays mainly to ^{18}Ne*(1887).
2769† *61*	(3/2,5/2$^+$)†	250† keV *50*		0.12† *4*	A	%p≈100 Decays mainly to ^{18}Ne*(1887).
4371‡ *10*	3/2$^-$‡	30‡ keV *10*			A	%p≈100 Decays to ^{18}Ne$_{g.s.}$
4903‡ *10*	3/2$^-$‡	50‡ keV *10*			A	%p≈100 Decays to ^{18}Ne$_{g.s.}$
5585‡ *32*		695‡ keV *72*			A	%p≈100 Sequential decay via ^{18}Ne*(4520,4523) to ^{17}F$_{g.s.}$ is suggested.
5809‡ *76*		0.46‡ MeV *22*			A	%p≈100 Sequential decay via ^{18}Ne*(4589) to ^{17}F*(495) is suggested. E(level): 5809 and 5815 probably correspond to different decay modes of the same state.
5815‡ *17*		141‡ keV *18*			A	%p≈100 Sequential decay via ^{18}Ne*(5106,5153) to ^{17}F$_{g.s.}$ is suggested.

† From (2008Pe02).
‡ From (2005De15).

P(^{18}Ne,p):resonances 2003An02,2005De15,2008Pe02

There have been a few separate campaigns to measure the structure of ^{19}Na using the Inverse Kinematics technique to obtain the resonant ^{18}Ne(p,p) excitation function. See also the theoretical analysis in (2014Ja05).

2003An02,2003An28,2004An28: ^{18}Ne ions were produced using the ^{19}F(p,2n) reaction, accumulated in an ECR source and re-accelerated to yield E(^{18}Ne)=21, 23.5 and 28 MeV beams using the Louvain-la-Neuve CYCLONE110 cyclotron. The beams, with average intensities of 4×10^6 pps, impinged on 0.520 mg/cm^2 polyethylene (CH_2) targets. A thin 8.0 μg/cm^2 layer of ^{197}Au was evaporated on the target's upstream surface. Recoil protons from scattering in the target were measured using two segments of the Louvain-la-neuve Edinburg Detector Array (LEDA) Si array; the protons were identified by their energy signal along with the relative time-of-flight when compared with the the cyclotron RF signal. Only the forward angles at θ_{lab}=4.9°−11.7° and 22.6°−29.9° were covered with angular resolutions of $\Delta\theta\approx0.2°$ and 0.9°, respectively. Mylar absorber foils of sufficient thickness to stop any scattered ^{18}Ne particles were place infront of all but one LEDA detector sectors; the "bare" sector was used to measure the ^{197}Au(^{18}Ne,^{18}Ne) reaction and provide an intrinsic normalization to the Rutherford cross section.

The data, which covered the energy range of E_{cm}=0.7-1.5 MeV and various angles in the range of θ_{cm}=120°−170°, were evaluated via R-matrix analysis. A single Jπ=1/2$^+$ resonance with E_{cm} =1066 keV *3* and Γ_p=101 keV *3* is deduced.

2005De15,2006DeZU: A beam of E(^{18}Ne)=7.2 MeV/nucleon ions was produced by fragmenting ^{20}Ne on a ^{nat}C target to yield ^{18}Ne atoms. The ^{18}Ne atoms were accumulated and re-accelerated using the GANIL/SPIRAL CIME cyclotron. The beam impinged on a 1.050 mm thick cryogenic solid hydrogen target that was contained by two 6 μm Mylar windows. While the target was thick enough to fully stop the incident beam, scattered protons escaped the target and were detected using a position sensitive ΔE-ΔE-E Si detector telescope that covered ±4.5° in the lab frame. The ejected energy spectrum was evaluated using standard Thick Target Inverse Kinematics (TTIK) analysis techniques to obtain the reaction excitation function. The energy resolution was measured as 30 keV *10*.

Six peaks were evident in the excitation spectrum at $E_{cm}\approx$1100, 2400, 3100, 4400, 5000 and 5900 keV. The spectrum was analyzed using the ANARKI R-Matrix code with significant input from a shell model calculation that relied heavily on a comparison with analog states in ^{19}O. Guided by the ^{19}O comparison, elastic scattering resonances were deduced at E_x= 756 keV *18*, 4371 keV *10* and 4903 keV *10*, with Jπ=1/2$^+$, 3/2$^-$ and 3/2$^-$ and Γ=80 keV *20*, 30 keV *10* and 50 keV *10*, respectively.

By including inelastic scattering from Jπ=5/2$^+$ and 3/2$^+$ states predicted at $E_x\approx$3200 and 3700 keV to ^{18}Ne*(1887), the peaks at $E_{cm}\approx$2400, 3100 keV could be qualitatively reproduced, but the amplitude for these inelastic states was unreasonable. However, in order to fit these peaks it was necessary to consider inelastic scattering to the proton-unbound states of ^{18}Ne and the subsequent p-decay to ^{17}F. The two-proton (multiplicity=2) events were analyzed to gain insight into likely contributions from this more complex reaction process. The analysis is consistent with ^{19}Na states at E_x=5585, 5815 and 5809 keV that 2-p decay, via ^{18}Ne*(4523,4589,5106,5153) intermediate states to ^{17}F*(0,495).

2006Sk09: A beam of ^{18}Ne ions, produced via the ^{3}He(^{16}O,^{18}Ne) reaction at Notre Dame using an 80 MeV oxygen beam, was purified in the TwinSol magnetic analyzer brfore impinging on a 5.52 mg/cm^2 thick CH_2 polyethylene target that fully stopped the incident beam. Scattered protons were measured at θ_{lab}=7.5°, 22.5° and 37.5° with an energy resolution near 30 keV. The elastic scattering energy range from $E_{cm}\approx$0.75-2.5 MeV was covered in the excitation function measurement.

A Jπ=1/2$^+$ state with E_x=0.74 MeV *3* and Γ=130 keV *50* was observed. In addition, no further states at higher energies are observed; this lends credibility to the interpretations of (2005De15). It supports the notion that the peaks observed in (2005De15) are populated by processes other than elastic scattering. Some discussion on spectroscopic factors is given in the text.

2008Pe02,2006AcZY: ^{18}Ne ions were produced using the ^{19}F(p,2n) reaction, accumulated in an ECR source and re-accelerated to yield a E(^{18}Ne)=66 MeV beam using the Louvain-la-Neuve CYCLONE110 cyclotron. The beam impinged on a 2 mg/cm^2 polyethylene (CH_2) target; afterward it was stopped in a Faraday cup. Recoiling protons were detected in an annular ΔE-E Si detector telescope that covered θ_{lab}=4.7°−20.2° with an overall energy resolution of 105 keV.

Elastic and inelastic scattering components were separated and obtained at seven angles. Two states at E_{res}=2.78 and 3.09 MeV, with Γ=105 and 250 keV, respectively, are observed strongly in the inelastic channel; a spin order of Jπ=5/2$^+$ and 3/2$^+$ is assumed.

S(p)(^{19}Na)=−322 *11* (2012Wa38).

P(^{18}Ne,p):resonances 2003An02,2005De15,2008Pe02 (continued)

^{19}Na Levels

E(level)	J^π	Γ	L	$(2J+1)\Gamma_0/\Gamma_{tot}$	Comments
745 *12*	$1/2^+$	101 keV *3*	0		E(level),J^π,Γ,L: from (2003An02). Others: (2005De15,2006Sk09). E_{res}(cm)=1066 keV *3* (2003An02). E_{res}(cm)=1076 keV *6*, Γ_p=80 keV *20* (2005De15), and E_x=740 keV *30*, Γ=130 keV *50* (2006Sk09). E(level): corresponding level is at 1471.7 keV in mirror nucleus ^{19}O.
2459† *32*	$(5/2,3/2)^+$†	105† keV *10*		0.43† *5*	E_{res}(cm)=2780 keV *30* (2008Pe02), uncertainty of 10 keV is also given in the abstract of (2008Pe02).
2769† *61*	$(3/2,5/2^+)$†	250† keV *50*		0.12† *4*	E_{res}(cm)=3090 keV *60* (2008Pe02), uncertainty of 50 keV is also given in the abstract of (2008Pe02).
4371‡ *10*	$3/2^-$‡	30‡ keV *10*			
4903‡ *10*	$3/2^-$‡	50‡ keV *10*			
5585‡# *32*		695‡ keV *72*			Sequential decay via ^{18}Ne*(4520,4523) to $^{17}F_{g.s.}$ is suggested.
5809‡# *76*		0.46‡ MeV *22*			Sequential decay via ^{18}Ne*(4589) to ^{17}F*(495) is suggested. E(level): 5809 and 5815 probably correspond to different decay modes of the same state.
5815‡# *17*		141‡ keV *18*			Sequential decay via ^{18}Ne*(5106,5153) to $^{17}F_{g.s.}$ is suggested.

† From (2008Pe02).
‡ From (2005De15).
# The TTIK excitation function of (2005De15) shows broad peaks consistent with $E_x \approx 2100$ and 2800 keV; a plausible explanation based on inelastic scattering by states near $E_x \approx 3500$ keV was explored, but not accepted since the expected amplitude was too low to explain the data.

^{9}Be(^{20}Mg,^{19}Na) 2010Mu12

2010Mu12: The decay product particle correlations for two-proton decay of ^{20}Mg and one-proton decay of ^{19}Na were evaluated. Angular correlations were measured; momenta were not measured; hence properties of excited states are deduced based on GEANT simulations of the p-^{18}Ne and (p_1-^{18}Ne)(p_2-^{18}Ne) angular correlations.

A 591 MeV/nucleon beam of ^{24}Mg, from the SIS facility at GSI, was used to produce a beam of 450 MeV/nucleon ^{20}Mg in the FRS. Following breakup of ^{20}Mg in a ^{9}Be target, the angular correlations were analyzed to determine: the ^{20}Mg decay mode (2p or sequential proton decay) and the excitation energies of states involved in the reactions.

2004Ze05: The invariant mass of ^{18}Ne+p ejectiles was determined following interactions of 43 MeV/nucleon ^{20}Mg ions with a 47 mg/cm^2 ^{9}Be target at GANIL. The ^{18}Ne ejectiles were momentum analyzed using the SPEG spectrometer while protons were detected using eight telescopes of the position sensitive MUST array. The energy resolution was cited as 150 keV. A peak at E_x≈0.16 MeV *11* was observed, and associated with contributions from both the ground and first excites states.

^{19}Na Levels

E(level)	Γ	Comments
0	<40 keV	E(level): From Q_{1p}(^{19}Na)=0.328 MeV *22* group (2010Mu12) which is associated with ^{19}Na decay to $^{18}Ne_{g.s.}$ observed in analysis of (p_1-^{18}Ne)(p_2-^{18}Ne) correlations from ^{20}Mg breakup. 2010Mu12 state that Γ<40 keV reflects the experimental resolution of the detector system. The actual Γ is expected to be <1 eV.

^{24}Mg(p,^{6}He) 1969Ce01

Population of ^{19}Na was first observed using the ^{24}Mg(p,^{6}He)^{19}Na reaction. A 54.7 MeV proton beam, from the Berkeley 88-inch cyclotron, impinged on a thin ^{24}Mg target. A pair of Si detectors comprising ΔE-ΔE-E-VETO transmission detectors was used to identify the reaction products. Discussion on careful analysis to discriminate against erroneous ^{6}He events is given in the text.

A single peak is observed in the ^{6}He energy spectrum corresponding to a mass excess ΔM=12974 keV *70* (1969). The discovery of the first excited state at E_x=120 keV (1975BE38) suggests that the peak observed here is made up of the unresolved ground and first excited states. The observed cross section is $\sigma(\theta_{lab}=14.1^\circ)\approx 120$ nb/sr.

^{19}Na Levels

E(level)
0

^{24}Mg(^{3}He,^{8}Li) 1975Be38

The ground and first excited states of ^{19}Na were populated in the ^{24}Mg(^{3}He,^{8}Li) reaction.

A beam of 76.8 MeV ^{3}He ions, from the MSU K50 cyclotron, impinged on a 80 μg/cm^2 ^{24}Mg target (mounted on a 20 μg/cm^2 backing). Reaction products were measured using a magnetic spectrograph positioned at θ_{lab}=7.6° and 10.0°. The focal plane was energy calibrated using several reactions, including ^{24}Mg(^{3}He,^{6}He), ^{24}Mg(^{3}He,^{6}Li), and ^{24}Mg(^{3}He,^{7}Li).

Two peaks are observed in the spectrum, the ground state (at ΔM=12928 keV *12*) and the first excited state (at ΔM=13048 keV *15*). In the figure, the widths appear narrower than 100 keV (from evaluator).

^{19}Na Levels

E(level)	J^{π} †
0	(5/2$^+$)
120 *10*	(3/2$^+$)

† From comparison with ^{19}O.

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