Forming the wide asynchronous binary asteroid population

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We propose and analyze a new mechanism for the formation of the wide asynchronous binary population. These binary asteroids have wide semi-major axes relative to most near-Earth-asteroid and main-belt-asteroid systems as shown in the attached table. Confirmed members have rapidly rotating primaries and satellites that are not tidally locked. Previously suggested formation mechanisms from impact ejecta, from planetary flybys, and directly from rotational-fission events cannot satisfy all of the observations.

The newly hypothesized mechanism works as follows: (1) these systems are formed from rotational fission, (2) their satellites are tidally locked, (3) their orbits are expanded by the binary Yarkovsky-O'Keefe-Radzievskii-Paddack (BYORP) effect, (4) their satellites desynchronize as a result of the adiabatic invariance between the libration of the secondary and the mutual orbit, and (5) the secondary avoids resynchronization because of the YORP effect. This seemingly complex chain of events is a natural pathway for binaries with satellites that have particular shapes, which define the BYORP effect torque that acts on the system. After detailing the theory, we analyze each of the wide-asynchronous-binary members and candidates to assess their most likely formation mechanism. Finally, we suggest possible future observations to check and constrain our hypothesis.

Asteroid System	$a_\odot$ (AU)	$e_\odot$	q	R_p (km)	a (R_p)	a (km)	P_p (P_d)	P_p (hr)	P_s (P_d)	P_s (hr)
317 Roxane[a]	2.29	0.09	0.023[b]	9.4[b]	27	257[b]	3.5	8.2[c]	...	...
1509 Esclangona (1938 YG)[d]	1.87	0.03	0.036[d]	4.3[e]	49	210[d]	1.4	3.3[f]	2.8	6.6[f]
1717 Arlon (1954 AC)[g]	2.20	0.13	>0.216[g]	3.9[h]	15	59[h]	2.2	5.1[g,*]	7.8	18.2[g,*]
4674 Pauling (1989 JC)[i]	1.86	0.07	0.033[i]	2.2[j]	116	250[i]	1.1	2.5[k]	...	...
17246 (2000 GL_{74})[l]	2.84	0.02	0.064[l]	2.3[h]	99	228[b]	...	...	...	...
22899 (1999 TO_{14})[m]	2.84	0.08	0.033[m]	2.7[n]	67	182[b]	1.7	4.0[o]	...	...
32039 (2000 JO_{23})[p]	2.22	0.28	0.275[p]	1.3[h]	32	42[h]	1.4	3.3[p]	4.8	11.1[p]
51356 (2000 RY_{76})[q]	1.81	0.11	0.009[q]	1.2[h]	9	11[h]	1.1	2.6[q]	...	...
1998 ST_{27}[r]	0.82	0.53	0.0034[r]	0.28[r]	16	4.5[s]	1.3	3.1[r]	2.6	$\lesssim$6.0[r]

Figure: The confirmed and suspected members of the wide-asynchronous-binary population.

Acknowledgements: Seth Jacobson would like to acknowledge the NESSF program for sponsoring his PhD thesis.