Comet C/2013 A1 Siding Spring — how treatment of data and non-gravitational effects can change our close-encounter predictions with Mars?

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We study the future dynamical evolution of comet C/2013 A1 Siding Spring. This comets comes from the Oort cloud (see $1/a_{\rm ori}$ in the table) and experiences close encounters with Mars on 19 October 2014. Our preliminary solutions are based on the positional data taken from the Minor Planet Center. The observational material contains 713 measurements from October 4, 2012 to March 3, 2014. At the moment of abstract submission the comet is more than 3 au from the Sun and non- gravitational (NG) effects are indeterminable in its motion. We analyze how selection and weighting of observations influence on the estimates of the comet position during its close encounter with Mars. We also include NG effects to our analysis by assuming a grid of various radial (described by constant parameter A_1) and/or transverse (A_2) components of NG acceleration. Additionally, to better understand future close approach to Mars, for each of models described above, a sample of 5001 virtual orbits (VOs; including the nominal orbit) were constructed by using method given by Sitarski (1998). Results of our preliminary investigations are summarized in the table, where the first two models describe pure gravitational motion and differ in data treatment (second solution based on weighted data, see also figure), the remaining solutions include NG acceleration in the model of motion.

Data treatment	A_1 in units of au/day^2	A_1	Nominal distance in units	μ of 10^{-4} au	σ	$1/a_{\rm ori}$ in units of 10^{-6}au^{-1}	$1/a_{\rm fut}$
non-weighted	–	–	9.0100	9.0108	0.0398	27.7±1.8	121.6±2.8
weighted	–	–	9.0901	9.0902	0.0301	33.0±1.0	123.2±1.8
non-weighted	10^{-8}	0	8.9851	8.9838	0.0461	27.7±1.8	124.7±2.8
non-weighted	10^{-7}	0	8.3932	8.3938	0.0395	27.7±1.8	152.0±3.0
non-weighted	10^{-6}	0	8.8745	8.8774	0.0220	27.7±1.8	−69.3±1.9
non-weighted	10^{-5}	0	102.9033	102.9040	0.0347	27.6±1.7	−190.7±1.7
non-weighted	10^{-7}	$+10^{-8}$	8.3978	8.3982	0.0398	27.7±1.8	71.2±3.0
non-weighted	10^{-7}	-10^{-8}	8.3898	9.0902	0.0301	27.7±1.8	232.8±3.0

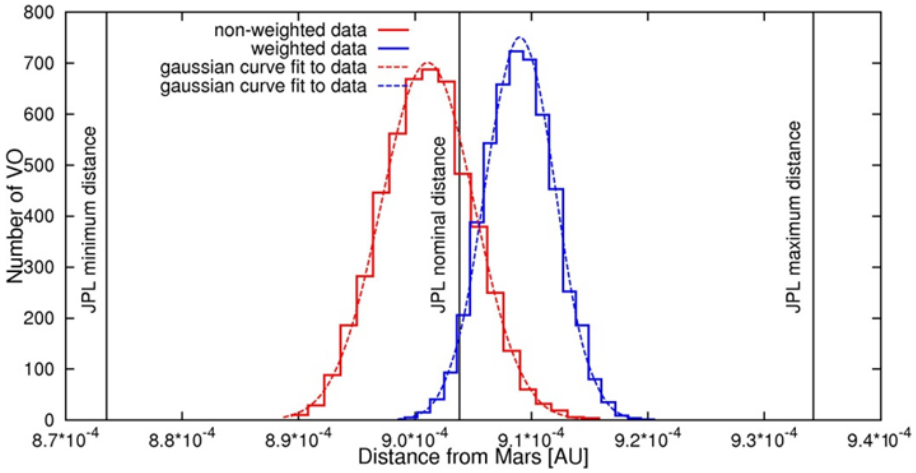

Figure: Cumulative distribution of all VOs and the nominal orbit of the comet C/2013 A1 Siding Spring during the close approach to Mars. Red curve shows results of non-weighted data, blue curve – weighted data. Gaussian fits to our numerical results are showed by dashed red and blue lines. We also included the data obtained from the JPL web pages by using the same observational arc as given here; JPL results are denoted by vertical straight lines.