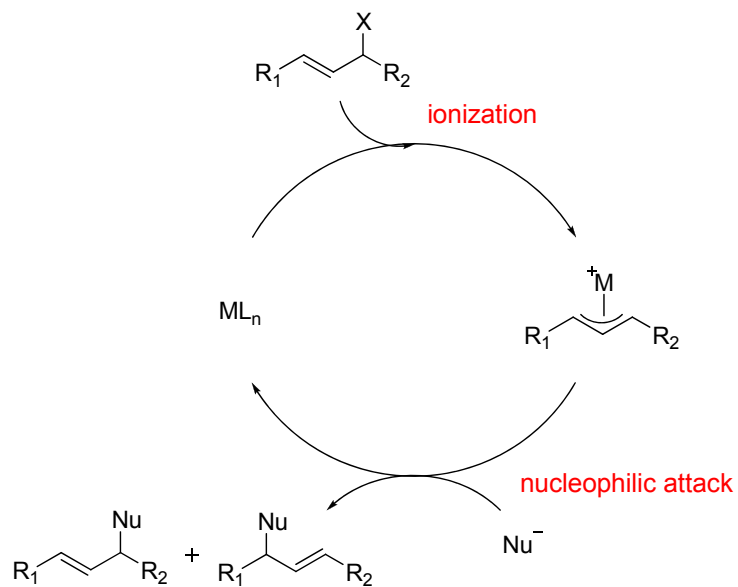
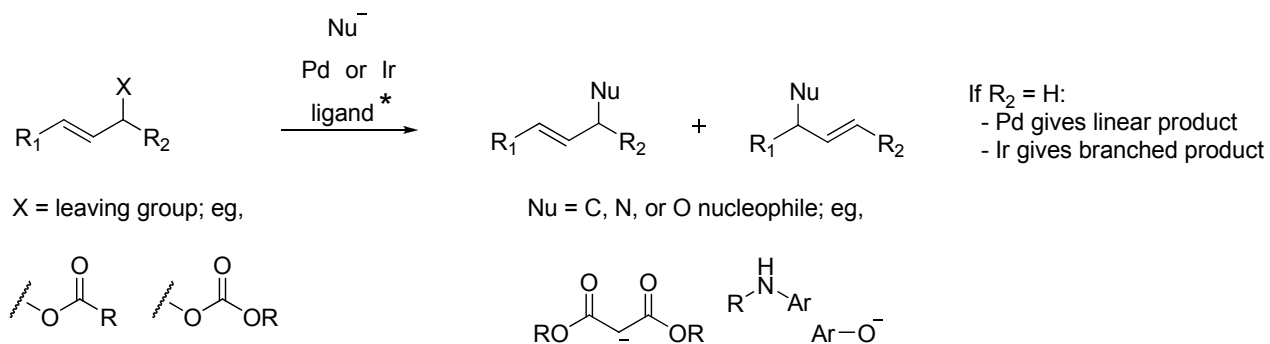


Pd- and Ir-Catalyzed Asymmetric Allylic Substitution

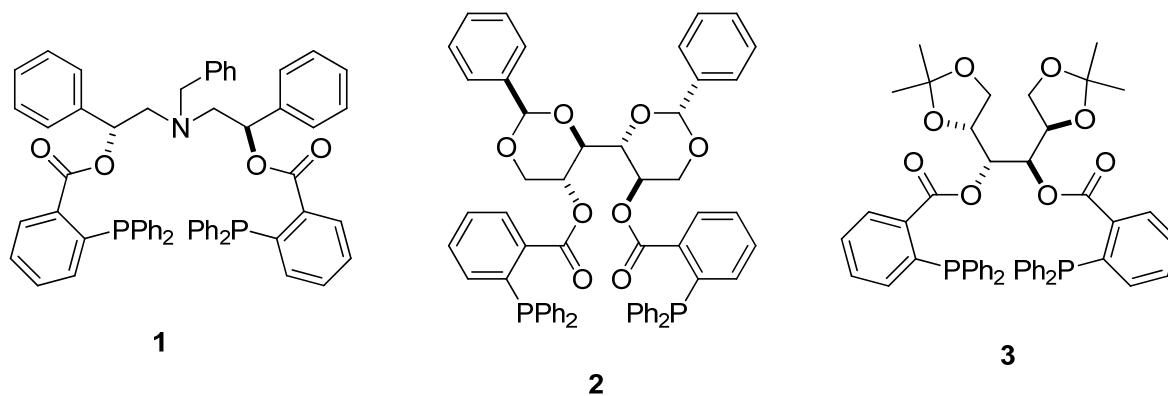
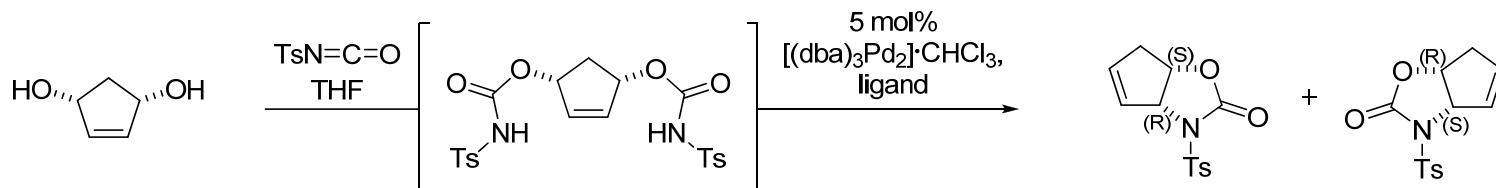
Kevin Olivier
January 22, 2010

General reaction scope and mechanism



Lloyd-Jones, G. C.; Norrby, P.-O. *et al.* *J. Am. Chem. Soc.* **2009**, *131*, 9945-9957.
 Borman, S. *Chemical & Engineering News* **87** (24), June 15, 2009, 31-33.

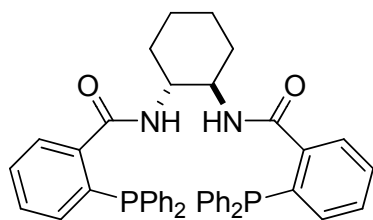
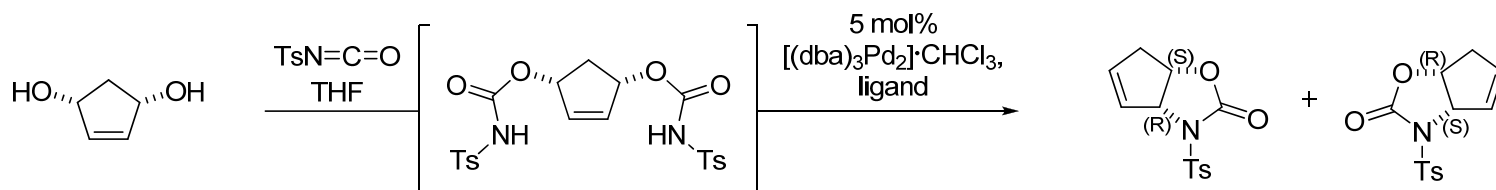
Trost ligands



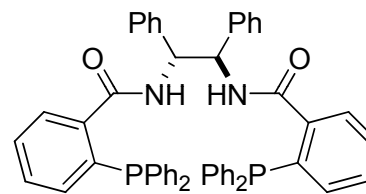
ligand	t (h)	T (°C)	yield (%)	ee (%)	product
1	1	0	100	60	(S,R)
2	8	0 to 20	98	61	(S,R)
3	9	-8 to 20	100	64	(S,R)

Trost, B. M.; Van Vranken, D. L. *Angew. Chem. Int. Ed. Engl.* **1992**, 31, 228-230.

Trost ligands



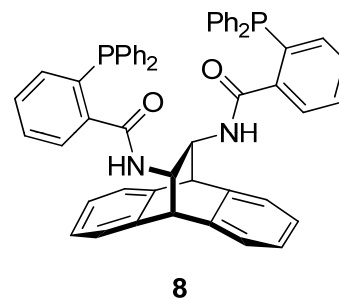
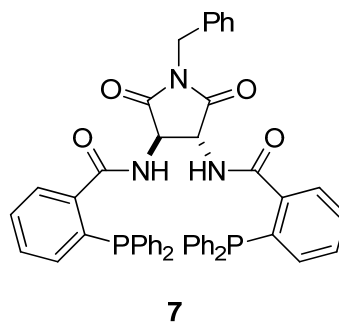
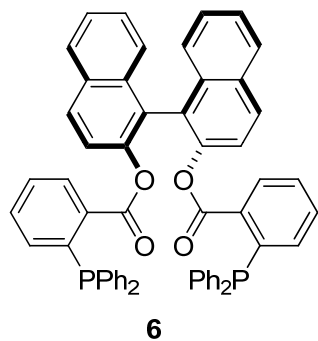
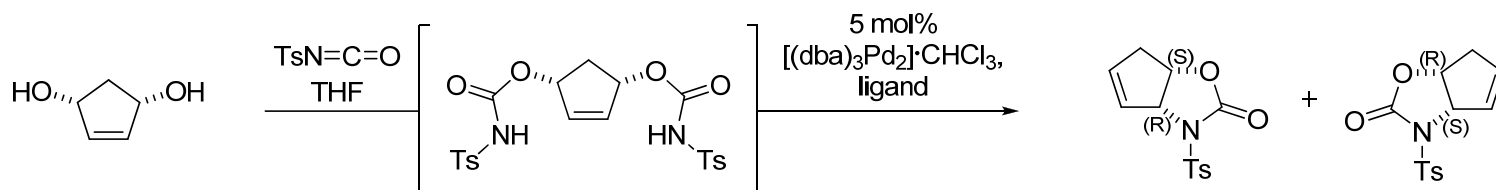
4



5

ligand	t (h)	T (°C)	yield (%)	ee (%)	product
4	1.5	0 to 5	97	78	(S,R)
5	1	0	97	80	(S,R)

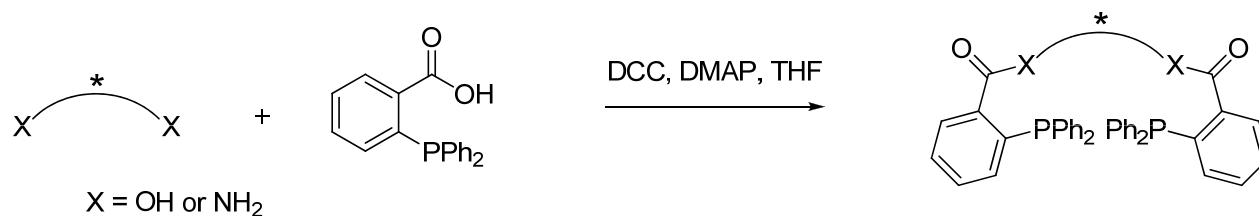
Trost ligands



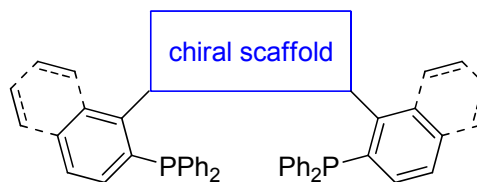
ligand	t (h)	T (°C)	yield (%)	ee (%)	product
6	5	20	87	40	(R,S)
7	2	0 to 5	68	75	(R,S)
8	0.33	0	94	88	(R,S)

Trost, B. M.; Van Vranken, D. L. *Angew. Chem. Int. Ed. Engl.* **1992**, 31, 228-230.

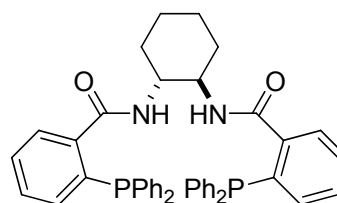
Trost ligands



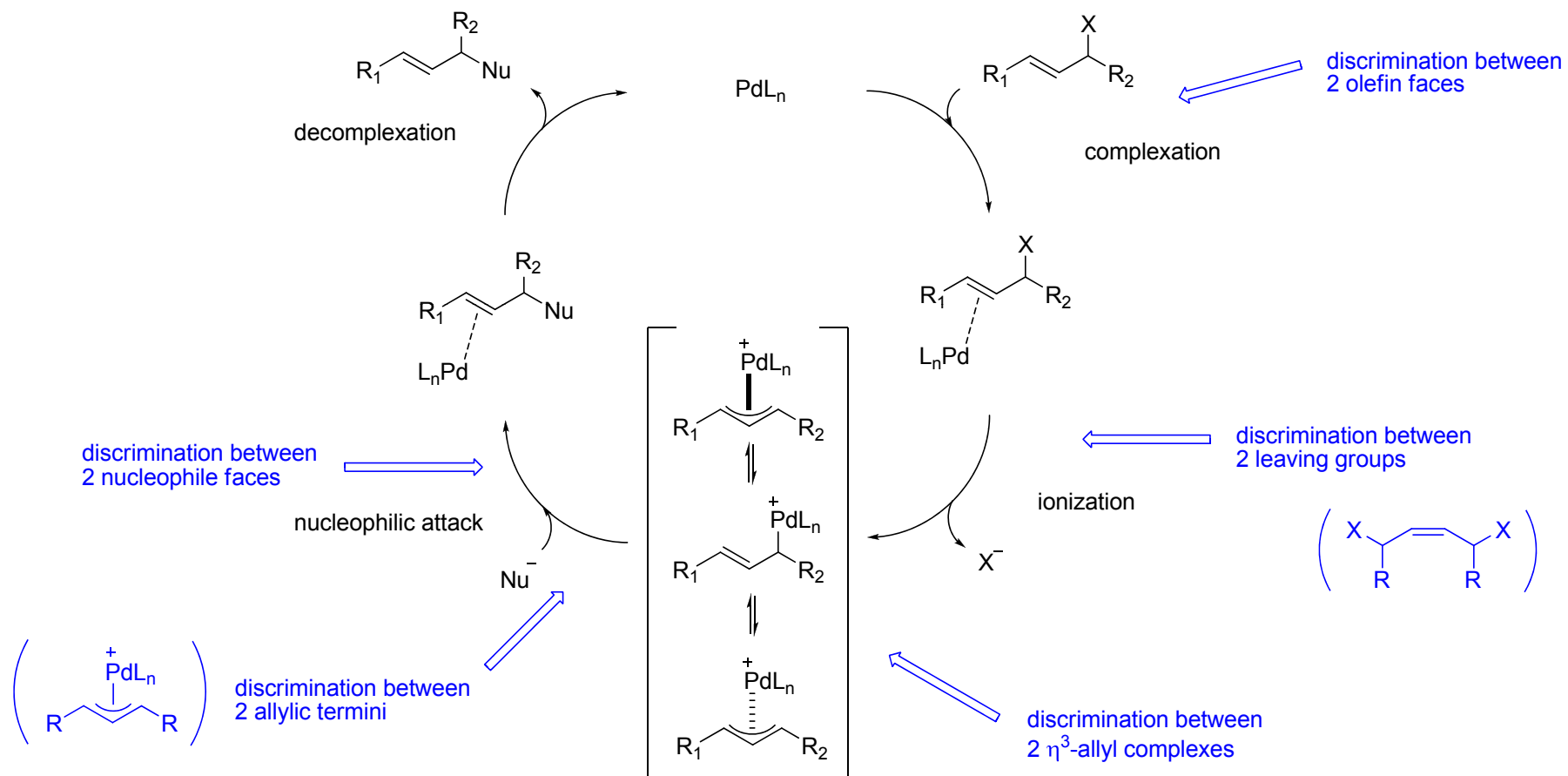
Trost Modular Ligand (TML)



Trost Standard Ligand (TSL)

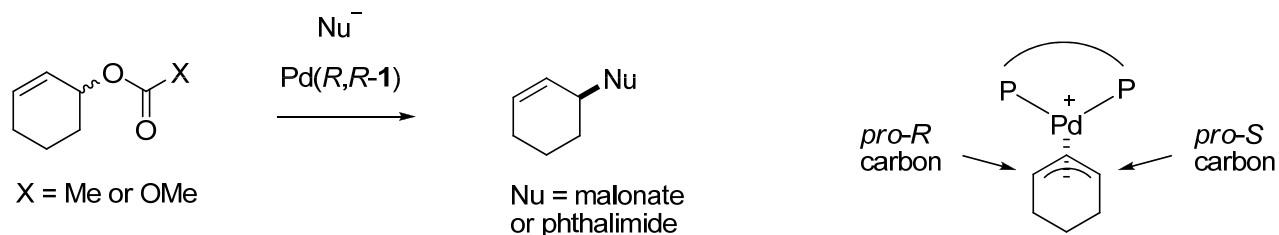


Mechanism and possibilities for enantioselection

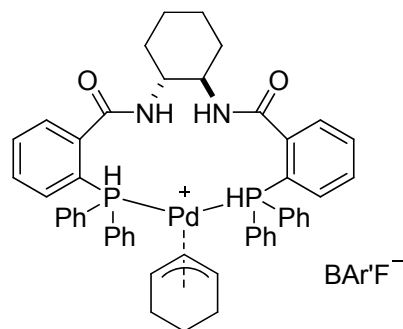


Isolation of the intermediate complex

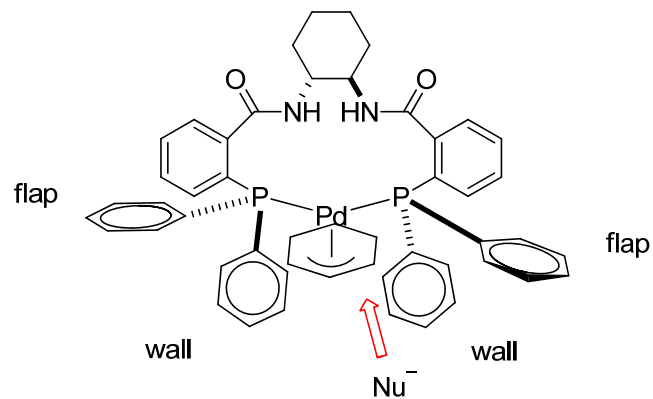
AAS of cycloalkenyl esters and carbonates:



NMR and computation used to elucidate solution-phase structure:

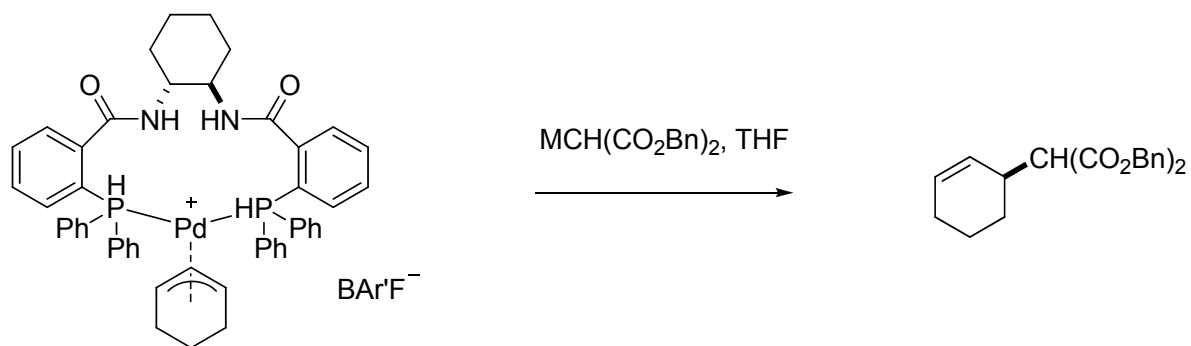


Trost's rationale for asymmetric induction



Dependence on counterion

The enantioselectivity depends dramatically on the counterion of the nucleophile.

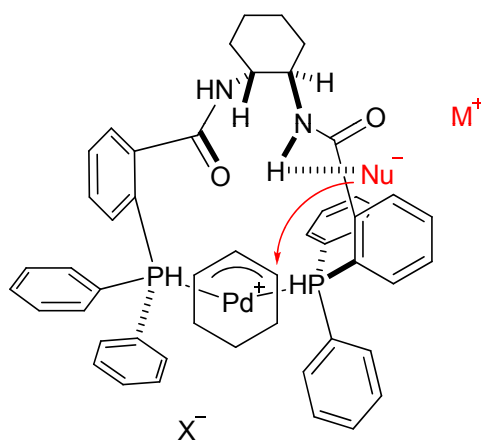


entry	M	ee (%)
1	Li	3
2	Na	44
3	K	76
4	Cs	89
5	Bu ₄ N	98

Trost, B. M.; Bunt, R. C. *J. Am. Chem. Soc.* **1994**, *116*, 4089-4090.

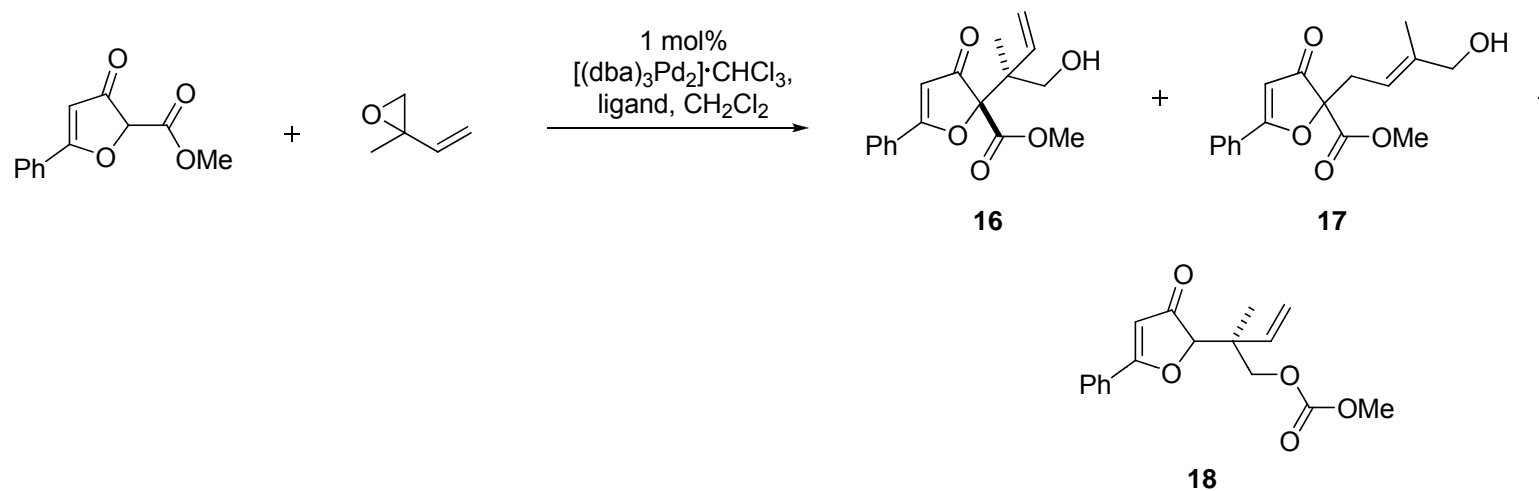
Lloyd-Jones, G. C.; Norrby, P.-O. *et al. J. Am. Chem. Soc.* **2009**, *131*, 9945-9957.

Lloyd-Jones' and Norrby's rationale for asymmetric induction



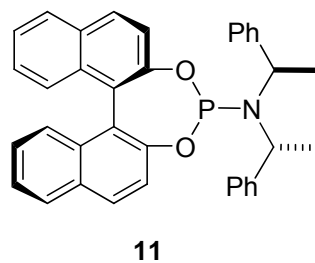
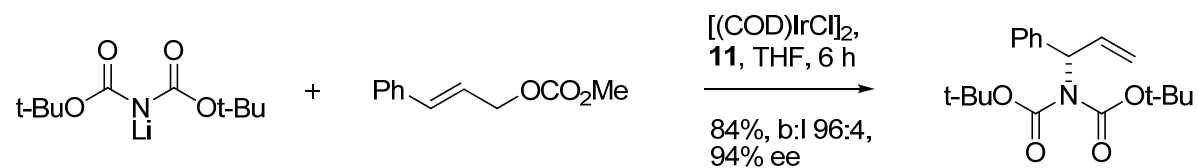
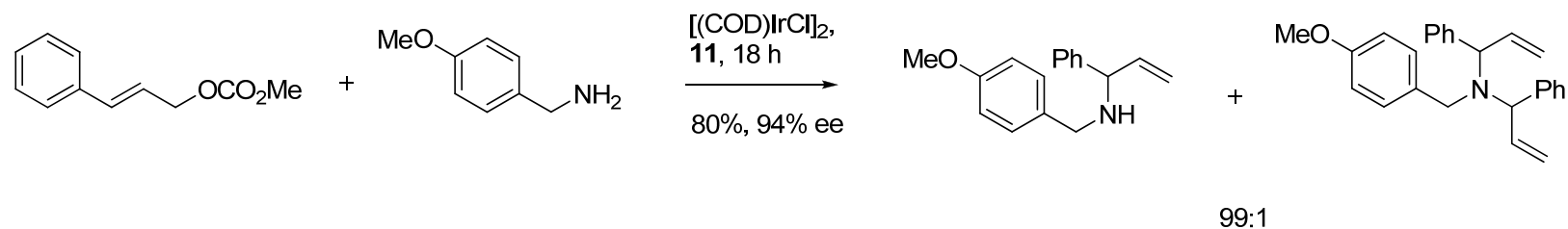
Lloyd-Jones, G. C.; Norrby, P.-O. *et al. J. Am. Chem. Soc.* **2009**, 131, 9945-9957.

Application in total synthesis

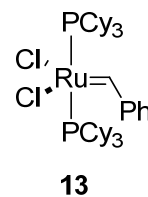
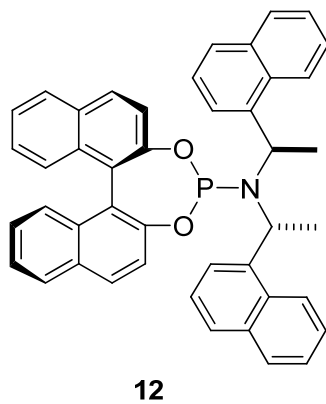
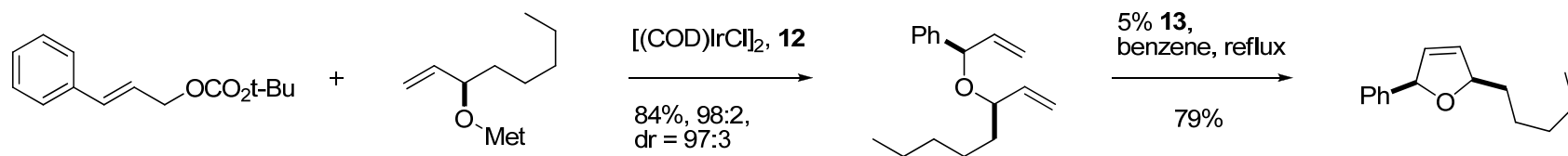


entry	ligand	t (min)	yield (%)			dr of 16	ee (%) of 16
			16	17	18		
1	4	30	0	30.6	61.3	-	-
2	4	10	66	31	0	8.7:1	95
3	15	10	59	26	0	26:1	99

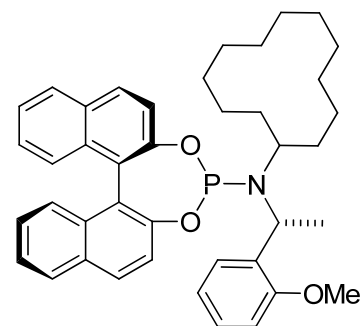
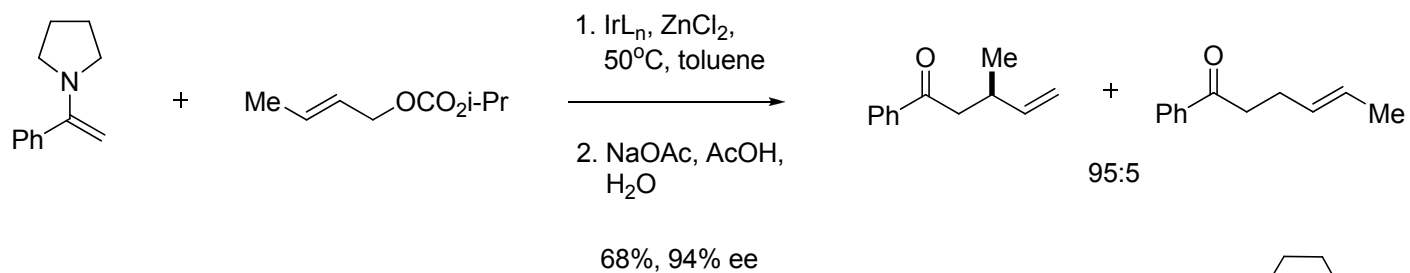
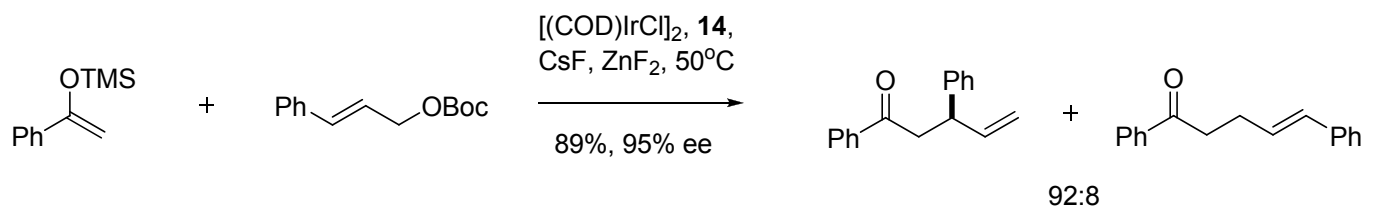
Synthetic utility of Ir-catalyzed AAS



Synthetic utility of Ir-catalyzed AAS



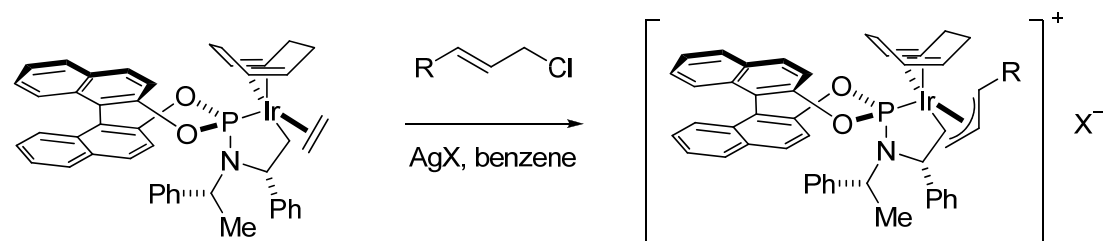
Synthetic utility of Ir-catalyzed AAS



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Hartwig, J. F.; Graening, T. *J. Am. Chem. Soc.* **2005**, *127*, 17192-17193.
Hartwig, J. F.; Weix, D. J. *J. Am. Chem. Soc.* **2007**, *129*, 7720-7721.

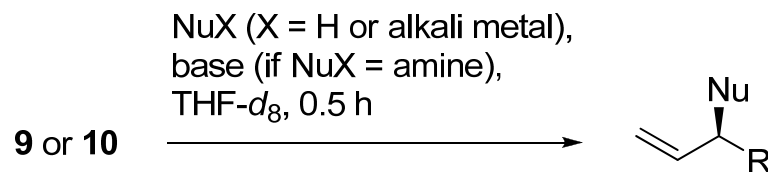
Isolation of the intermediate complex

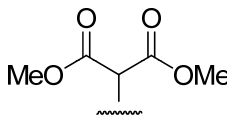
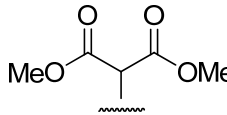
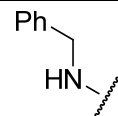
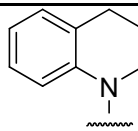
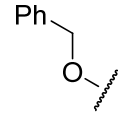


9: $R = H, X = OTf$
10: $R = Me, X = SbF_6$

NMR and X-ray used to elucidate structure.

Chemical and kinetic competence



entry	R	Nu	yield (%)	b:l	ee (%)
1	H		100	-	-
2	Me		95	95:5	84
3	Me		100	97:3	99
4	Me		96	96:4	98
5	H		55	-	-

Hartwig's rationale for asymmetric induction

